The Century Ahead

IN THE PETROLEUM INDUSTRY

commemorating oil's 100th anniversary

AUGUST 1959

the Petroleum Engineer

FOR MANAGEMENT

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THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 9 • VOLUME XXXI • AUGUST, 1959

The Conference Table **A-11**

"Man thinks, therefore he is free."

Management in the Year 2059 ..... **A-21**

You'll be able to put on an electronic information cap and your development course will emphasize chiefly ability to think.
— Gilbert C. Jacobus

Where Will Energy Come From in 2059? **A-24**

A distinguished scientist gives us a well analyzed forecast of supply and demand of petroleum and other energy sources through the coming century. *— Lewis G. Weeks*

What Will Politics Be Like in 2059? **A-32**

Communism will disappear . . . to be replaced by terrestial issues . . . Voters will participate in elections through electronic devices . . . Biggest danger, as now, will be ourselves.
— J. J. Wuerthner, Jr.

Exploding Technology — Management's Most Urgent Problem **A-34**

An industrialist warns executives they cannot make decisions today without technological understanding.
— Willard F. Rockwell, Jr.

E SECTION FOLLOWS A

Global Statistics **E-1a**

World-wide petroleum operation figures for 1958 in condensed form. *— Ernestine Adams*

Why Do People Act That Way? **E-2**

One of "How to be a Manager" series . . . This tell how to learn what motivates people and what to do about it.
— Robert W. Dorman

THE COVER . . . This picture isn't the Sahara. We know oil and gas wells will be pouring out production in that rich desert in a hundred years. The cover view is a scene on Mars and, we suppose, week-end cottages or facsimiles. The only detail we noticed was one that wasn't there — petroleum operations, of course. We can't tell whether the Martians don't have any oil or conduct their petroleum operations underground. Thanks to Walt Disney Studios for this picture of Mars.

DRILLING AND PRODUCING

The Changing Scene in Drilling and Producing B-19
— Gilbert H. Tausch

Operation Mohole B-24
— Willard Bascom

Underground Nuclear Explosions: Awesome Recovery Promise B-28
— Carl C. Anderson

Constructing Underground Storage Facilities with Nuclear Explosions . . B-32
— Roland H. Carlson

Seep-Sniffers at Sea B-40

Santa Rita No. 1 — Where Oil in West Texas Began B-44
— David L. Black

Production Fundamentals
Development & Evaluation of Gas Condensate Reservoirs, Part 4 B-46
— William C. Goodson

The Atlantic Lectures of The University of Texas
Part 10: What Is Miscible Displacement? B-56
— W. F. Kieschnick, Jr.

REFINING AND PETROCHEMICAL

Look to the Future C-3

What Human Mind Can Venture a Guess on Petroleum in 2059 A.D.? . . C-7
— Dr. C. Vernon Foster and Dr. R. N. Maddox

An Engineer Views 21st Century Petrochemical Plants C-11
— E. H. Ivey Jr.

Will the Next 100 Years Bring a "Push-Button" Industry? C-13
— Dr. Joseph F. Manildi

Breath of Life for Asphyxiated Refinery Employee C-17
— William E. Doering

Process Notebook C-19

Equilibrium Fluid Cracking Catalyst C-21
— J. J. Blazek and F. H. Macke

Distillation . . . In View of Modern Developments, Part 2
Distillation, Chapter 1 . . . . . C-22
— Kenneth F. Gordon and James A. Davies

Refinery Construction Manual
Part 11: Pump, Motors and Instruments C-26
— Henry Martyn Noel

Refining Engineer's Continuous Tables
Method for Calculating Octane Ratings of Gasoline Blends C-32
— George E. Mapstone

OIL AND GAS PIPELINING

THE CENTURY AHEAD
Everlasting Pipe . . . Infrared Welding . . . Machine Makes Pipe,
Ditches, Backfills D-23
— W. N. Gilliat

One-Man System Operation . . . Pushbutton Construction D-26
— R. C. Hunt

Changes in Pipelining Will Come Faster and Be More Drastic D-28
— L. F. Scherer

Potential Future Developments D-29
— J. E. Green

The Great Grid—2059 A. D.—Trans-America Pipeline Saves Nation D-30
— N. H. McAfee

Pipeline from North America to Europe in Near Future? D-32
— W. C. Kinsolving

What Jules Verne Said to Leonardo da Vinci D-33
— Darrell C. Morrow

2,000,000-psi Steel, 20-Hour Work Week? D-35
— W. T. Bulla, D. C. Palm, and C. S. Kenworthy

A New Pipeline Concept D-38
— Sydney S. Smith

FEATURES

The Course of Oil A-4
Petroleum People of 2059
Advertisers' Index A-6
Petroleum Profile A-8
J. C. Karcher
The Conference Table A-11
Highlights A-12
Meetings A-14
Management Personals E-14
The Trade Parade E-19
Books to Read E-30
Laugh with Barney E-31
Of Things to Come in Oil B-3
The Oasis B-99
Running Tour with Men in Industry B-100
Exploration Activities B-110
What's Doing in Drilling B-116
New Drilling and Producing Equipment B-119
New Drilling and Producing Literature . . B-123
New Refining Equipment C-36
New Refining Literature C-40
Refining Personals C-44
Pipeline Projects D-44
Canadian News Notes D-47
With the Pipeline Contractors D-48
Pipeline Personals D-51
New Pipeline Equipment D-53
New Pipeline Literature D-54

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THE PETROLEUM Engineer
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PETROLEUM PEOPLE OF 2059

WHAT WILL THE PETROLEUM industry be in 100 years? We can't know exactly, but in this issue some distinguished people have looked into their crystal balls and come up with some amazing prophesies. Lewis Weeks has calculated where energy will come from; others tell how the petroleum industry will operate. You'll have a glimpse of what politics and management will be like.

Now, what about the people in petroleum in 2059? Let's extrapolate.

Because we live so much longer, your own child may very well be living then. By that time, age 100 will be about what age 65 to 70 is now. It may be retirement age; there is already a tendency to increase the age of retirement.

Education will be tougher and broader and will take longer. Already many bachelor degrees require five years. To be sure of a job in the petroleum industry your great grandchild should have at least a master's degree. He'll have to have thorough grounding in science and in management because the scientist-engineer will also have to be able to deal with people in an era of exploding population and exploding technology. As Gilbert Jacobus says, as we move further into the era of depending on machines, we capitalize more upon the human intellectual potential.

The petroleum industry, which today owes its existence to science and technology, will demand more and more from its scientists and engineers.

AND SO WILL THE WORLD around them. The ivory tower of the scientist, the concentration of the engineer must fade before the rising banner of human goals. These people must be prepared to give their world the formulas for good relations of men and nations. With clear, objective thinking they must translate the elements of economics and politics into understandable theorems. These laws are as inexorable as the laws of nature, but fuzzy or power-seeking minds have distorted them beyond recognition.

Joseph Eley in this issue says that Communism will have disappeared by 2059. That is probably true simply because the Communist concept is opposed to fundamentals we have vaguely grasped in trial after trial. The engineer could write a Q. E. D. after these experiences that should deter more experiments along this line.

The Wall Street Journal recently ran an article under the heading, "United Fruit Company Finds Running 'Welfare' Firm Wins It Few Friends." The international oil companies have learned the same thing by experience and many are changing their policies. When will the world learn that man instinctively fights the living death of unearned fare?

In the past we have looked to the politicians — to business tycoons — to the ministry, to set up justice, to determine our living standards, to resolve our ethics. But their limited experiments have raised more questions than they've settled.

IN THE NEXT CENTURY we predict the scientist-engineer-managers will be called upon to distill the great verities of our universe — the laws of man as well as the laws of nature. They are the ones who can cross the lines of prejudice and write solutions to our historic problems. They must not only determine how to air-condition the cities of the future, they must help condition people to a world in which the only constant is change.

Our economics will be sounder with an engineer's studied results. Our politics could use the calm review of a scientist.

Even our ethics will be improved by these people who promise to be the leaders of the next century. The scientist *knows* you must give your life to gain it... the engineer *knows* you must go that second mile. The manager *knows* that basic truths must be communicated so each person can understand and apply them to his own life.

There is no one term for the scientist-engineer-manager that our civilization — and, in particular, our industry — is developing. But he is the man of the future — the man of the 21st century.

Ernestine Adams

FOR THE FIRST TIME IN A CENTURY...

the oil and gas industry has a symbol

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Heart of the Oil and Gas Industry

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ADVERTISERS' INDEX

A

ACF Industries, Incorporated — W-K-M Division B-90, D-20, D-21, D-39
Air Preheater Corporation, The D-12
Allied Chemical Corp., Solvay Process Division C-44
American Meter Company E-19, E-32
American Petroleum Institute E-29
Annin Company, The C-2

B

Baker Oil Tools, Inc. B-18, B-38, B-39, B-82, B-83
Barber-Greene A-36f
Baroid Division, National Lead Co. B-5, B-97
J. S. Beaird Company E-17
Bell Helicopter Corporation D-22
Bethlehem Steel Company, Supply Division D-43
Birdwell Division of Seismograph Service Corporation B-91
Brakeseal, Inc. E-30
Brown Oil Tools, Inc. B-118
Brown & Root, Inc. E-24
Bucyrus-Erie Company D-13
Burgess-Manning Co. E-30
Burndy D-4
B & W, Inc. B-119

C

Cable & Stephens B-124
Cabot Shops, Inc. B-1
Cameron Iron Works B-42, B-43
Catawissa Valve & Fittings Company E-22
Caterpillar Tractor Company E-1, E-28
Christensen Diamond Products B-101
Clark Bros. Co. E-8, E-9
Classified Advertising E-32
Colorado Fuel and Iron Corporation, The B-85
Continental-Emsco Company, a Division of The Youngstown Sheet and Tube Company B-58, B-59, B-95
Continental Oil Company B-8
Core Laboratories, Inc. B-114
Cosasco Division, Perfect Circle Corporation D-19
M. J. Crose Manufacturing Company, Inc. D-5
Crossett Chemical Company, The, Chemical Division B-115
Crutcher-Rolfs-Cummings D-49

D

Daniel Orifice Fitting Company, Incorporated B-108
Dayton Industrial Products Co., a Division of Dayton Rubber Company B-73
Dempster Brothers, Inc. A-17
Diamond Chain Company, Inc. B-98, B-99
Dodge Manufacturing Corporation B-12
Dowell ..... Inside Front Cover, A-13
Dresser Industries, Inc. A-18, A-19
Dresser Manufacturing Division D-45
Drilling Accessory & Manufacturing Co., Inc. D-52
Du Pont, E. I., de Nemours & Co., Inc. C-29, C-30

E

Ethyl Corporation C-4, C-5

F

Fairbanks, Morse & Co., Oil Field Division B-122
Fish Engineering Corp. A-10
Fisher Governor Company E-12, E-13
Fleetline Co. D-54
Foxboro Company, The D-2

G

Gardner-Denver Company B-105
Gase Pump & Burner Mfg. Co. A-36g
General American Transportation Corporation, Plate & Welding Division A-20
Geolograph Oil Field Service Co. B-117
Grove Valve & Regulator Company A-16
Guiberson Corporation, The B-13

H

Halliburton Oil Well Cementing Company ..... B-50, B-67, B-112, Back Cover
Harbison-Fischer Mfg. Co. B-102
Hardy-Griffin Engineering Corporation, a Division of Atlas Pipe, Inc. B-100
Hercules Tool Company B-123
H & M Pipe Beveling Machine Co. D-47
Hotel Figueroa E-25
Hotel Galvez E-31
Houdry Process Corporation C-40, C-41
Houston Oil Field Material Company, Inc. B-9
Hughes Tool Company B-86, B-87
Hycalog, Inc. B-124
Hydril Company B-35

I

Ingersoll-Rand D-14, D-15, E-23
Iverson Supply Company B-7

J

Jensen Bros. Mfg. Co. B-111
Johnston Testers, Inc. B-89
The S. M. Jones Company, Division of Buffalo Eclipse Corporation B-68
Jones & Laughlin Steel Corporation B-106, B-107

K

The M. W. Kellogg Company, a Subsidiary of Pullman Incorporated C-25
Koppers Company, Inc., Tar Products Division D-18

L

Lamar Hotel E-25
Lane-Wells Company ..... B-36, B-37, Inside Back Cover
Larkin Packer Company, Inc. B-10
Layne & Bowler, Inc. E-20
Lenape Hydraulic Pressing & Forging Co. C-46
Lone Star Steel Company A-5
Lufkin Foundry & Machine Company B-41
Lufkin Rule Company, The E-26

M

Mack Trucks, Inc. B-76
Magnet Cove Barium Corporation B-72
Maloney-Crawford Tank & Manufacturing Co. E-15
John N. Martin, Manufacturer B-11
Mayor-Kelley Company D-42
Mercantile National Bank E-23
Merla Tool Corporation B-113
Mid-Continent Supply Co. B-45
Miller Sand Pump Co. B-124
Minneapolis-Honeywell D-36, D-37
Mission Manufacturing Co. B-62
Motorola Communications & Electronics, Inc. D-9

Mc

McCord Corporation D-47
McCullough Tool Company B-6

N

National Supply Company, The B-51, B-52, B-53, B-54
National Tank Company E-34
National Tube Division of United States Steel B-16, C-38
Nicolet Industries, Inc. D-8
Nordberg Mfg. Co. D-16
Nordstrom Valve Division, Rockwell Manufacturing Company E-4, E-5
W. C. Norris, Manufacturer, Division of Dover Corporation B-81
Northern Ordnance, Incoporated, Subsidiary, Northern Pump Company E-26

O

Oil Center Tool Co. B-17
Oil Well Supply Division of United States Steel A-7
Orbit Valve Company B-94
Otis Engineering Corporation B-104

P

Pacific Valves, Inc. C-42
Parkersburg Rig & Reel Company, The B-65
Perforating Guns Atlas Corporation B-71
Petreco, a Division of Petrolite Corporation C-34, C-35
Petro-Chem Development Co., Inc. A-15
Petroleum Electric Power Association E-16
Petroleum Equipment Suppliers Association B-49
Pipeline Cleaners Co. D-53
Pipe Linings, Division of American Pipe and Construction Co. A-36d
Polyken Products, Division of The Kendall Co. D-1
Wm. Powell Company, The A-36h

R

Radiator Specialty Co. C-45
Rector Well Equipment Company, The B-109
Reda Pump Company B-111
Reed Roller Bit Company B-74, B-75
Reilly Tar & Chemical Corporation D-11
Republic National Bank of Dallas A-1
Rockford Clutch Division, Borg-Warner B-110
Rust-Oleum Corporation A-9

S

Schlumberger Well Surveying Corporation B-63
Security Engineering Division B-55
Shaffer Tool Works B-120, B-121
Shamrock Village E-31
M. B. Skinner Co. C-45, D-54
Nowery J. Smith Co. C-39
Tyson Smith Co. B-103
Southern Pipe, Division of U. S. Industries Inc. D-50, D-51
Southwestern Plastic Pipe Co. B-108
Standard Oil Company of California E-33
Standard Oil Company (N. J.) E-6, E-7
Stearns-Roger Mfg. Co., The C-16
Steel Forgings, Inc. D-54
Stratford Engineering Corporation C-43
Sun Ship Building & Dry Dock Co. C-1

T

Teletype Corporation D-3
Texaco, Inc. E-18
Thompson Tool Co. B-96
Thornhill-Craver Company B-2
Tretolite Division, The Petrolite Corporation B-14

U

Union Switch & Signal Division of Westinghouse Air Brake Company D-6, D-7
United States Steel Stainless Steel C-6
Universal Atlas Cement Company B-64
Universal Oil Products A-36e, C-31, D-17

V

Valley Electric Company E-27
Henry Vogt Machine Co. A-36a

W

Warner-Lewis Company D-10
Wash Overshot & Spear Engineers, Inc. B-88
Waukesha Motor Company B-4, B-69
Welex, Inc. B-92, B-93
The Western Company B-57
Wheeling Machine Products Company E-27
White Diesel Engine Division, The White Motor Company E-21
Wickwire Rope, The Colorado Fuel and Iron Corporation B-78, B-79
Wheland Company, The B-15
Wilson Supply Company B-60, B-61

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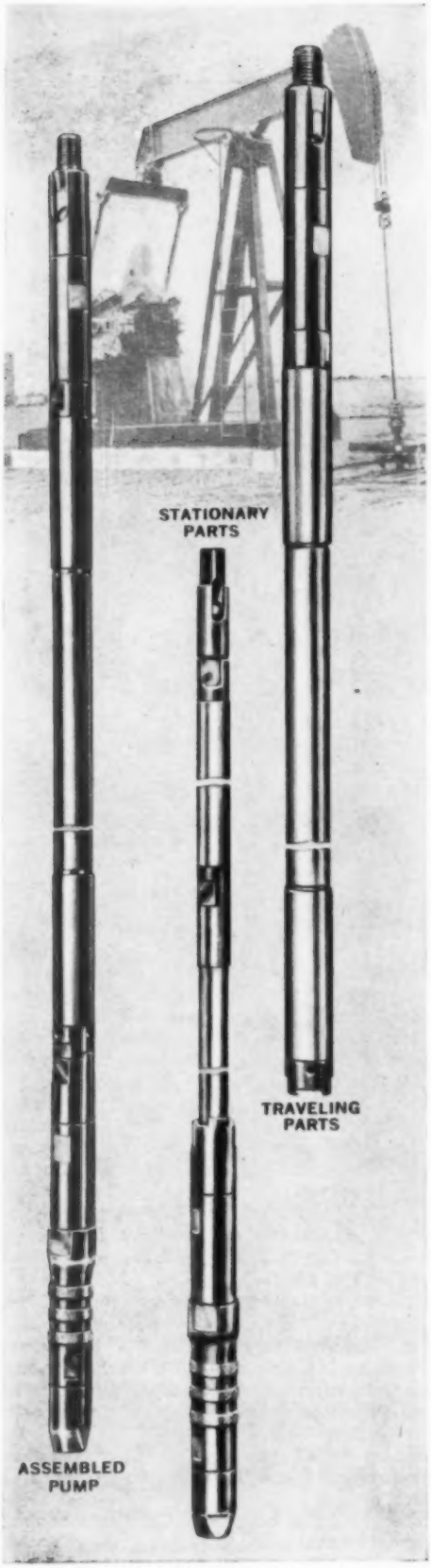

Here are some money-saving tips about deep-well pumping

EVERY WELL OPERATOR wants to get his production at lowest cost, and proper selection of equipment can contribute substantially toward achieving this goal.

When pumping below 7,000 feet, for example, it is a frequent practice to install 1¼" standard barrel pumps in 2" tubing. This combination is not economical in many of the deeper wells because high pressures cause distortion of the pump barrel and excessive wear on pump parts, necessitating costly stoppages to pull the pump for maintenance work. At these depths, impact loading often causes the early failure of standard-wall pump barrels.

"Oilwell" builds HEAVY-WALL pump barrels

. . . with thicker walls which have the strength to operate properly under high pressure conditions. Furthermore, these pumps (1¼" maximum for 2" tubing, 1¾" for 2½" tubing) can be made to produce as much fluid by a compensating increase in stroke length, pumping speed, pumping time, or a combination of all three.

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You can get heavy-wall construction in HI-BRIN or KROM-I-DEE qualities. Each of these exclusive "Oilwell" barrels is strong and abrasive-resistant and designed to meet a particular corrosive condition.

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Petroleum Profile

"MEET ME IN ST. LOUIS" doesn't mean a musical to Dr. J. C. Karcher. The words were a signpost to a new career. They came over the telephone from Dr. Everett DeGolyer, vice president of Amerada, in Tulsa, to the young scientist in Chicago.

At the meeting in St. Louis March 25, 1925 the two men took an hour in the Union Station to organize the Geophysical Research Corporation, with DeGolyer as president and Karcher as vice president.

It was a fateful meeting for the two and for the petroleum industry. From it came a new kind of search for oil — the science of physics was used to achieve the needs of the explorer.

John Clarence Karcher had already proved he was no ivory tower scientist. In order to go to high school at Hennessey, Oklahoma, four miles from his father's farm, he got a job as assistant janitor. He worked also at Oklahoma University, but it didn't prevent him from getting the highest grades in his graduating class of 1916 and becoming a Phi Beta Kappa. This record brought several offers of scholarships and he chose the Tyndale Fellowship at University of Pennsylvania. He was awarded a PhD in 1920 in physics and mathematics.

During World War I, however, formal education was suspended while young Karcher served as a liaison between the military and the Bureau of Standards on sound ranging. Then he was a technical attache at the U. S. Embassy in Paris in 1918.

After receiving the doctorate the scientist went back to the Bureau of Standards. He and two other men in the Bureau, Dr. E. A. Eckhardt and Burton McCollum, discussed the possibility of using reflected sound waves to locate subsurface structures that could be oil traps. About this time the head of Oklahoma University's physics department, Dr. William P. Haseman, who had worked with his student on the idea of reflection seismograph for oil prospecting, persuaded some Oklahoma City oil men to put up enough money to back Geological Engineering Company, the first geophysical company in the country. In the summer of 1921 a brain trust was assembled to experiment in north Oklahoma. Besides Haseman and Karcher there were Dr. D. W. O'Hern, formerly state geologist, Dr. Irving Perrine, formerly head of Oklahoma University Department of Geology, McCollum (now head of McCollum Exploration Company, Houston, Texas), and Dr. Eckhardt.

This field trip was probably the first seismograph exploration party in the United States.

The experiments worked out fine but economics defeated them. The scientists figured it would cost about 75 cents a barrel to find oil. About that time Burbank and Tonkawa fields came in and oil went to 50 cents a barrel. Companies couldn't see paying Geological Engineering to find oil at those estimated prices.

Then came a diversion in his career that might have changed it for good except for the "Meet me in St. Louis" episode. Karcher was offered double his salary to join Western Electric. He had had his salary doubled the second time and had been made head of an engineering division of development (because of important innovations he made in operations) when Dr. H. V. Bozel, an O.U. engineering professor, arranged a meeting between DeGolyer and Karcher. The physicist leaped to the bait of developing his pet project — the reflection seismograph.

The new company, affiliated with Amerada, had $100,000 for research. Karcher went looking for the brainpower to use it. Some distinguished names made up the employees: Dr. F. M. Kannenstine, Dr. E. E. Rosaire, Dr. D. D. Weatherby, Dr. H. B. Peacock, Eugene McDermott, and Henry Salvatori.

J. C. Karcher
President
Concho Petroleum Company

The new method worked. It found oil.

Karcher sold his interest in Geophysical Research Corporation and in 1930 Geophysical Service, Inc., was organized with headquarters in Dallas, Texas. The company is still pre-eminent in its field. DeGolyer left Amerada in 1932 and came to Dallas.

GSI brought in so many properties on a contingent fee (such as a quarter interest in Old Ocean field) that Karcher and DeGolyer set up a separate corporation to handle it. This was Coronado Corporation, later sold to Stanolind.

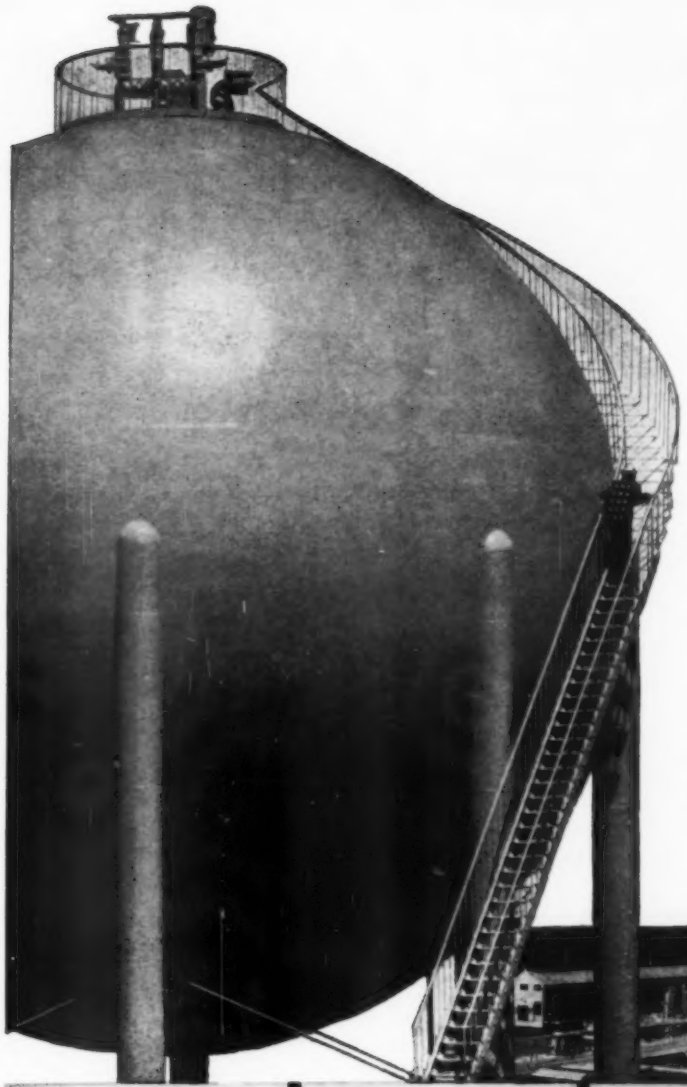
The geologist and the physicist — DeGolyer and Karcher — sold GSI to four key employees: McDermott, Eric Jonsson, Peacock and Cecil Green and these in turn organized Texas Instruments. DeGolyer went to Washington. Karcher organized the highly successful Comanche Corporation, which was liquidated in 1950. Later he established Concho Petroleum Company, which he still operates from Dallas.

Both his son, Paul, and son-in-law, D. J. Stone (married to Colleen Karcher), operate oil companies. Stone owns the Alamo Corporation in Lubbock, Texas, and J. Paul Karcher works out of Midland.

Dr. Karcher says our industry has become so specialized, there is no time to go into anything but one's own specific work. But his career denies his theory. He has been a scientist-executive all his life. Karcher's science had a dynamic influence in the adolescent days of the oil industry. And he handles his companies effectively and keeps, too, the ever-eager quest of the wildcatter.

Once when he shot a huge bull elk on a hunting trip in Wyoming, a companion said "Isn't that the greatest thrill you ever had?"

Dr. Karcher shook his head — "No, the greatest thrill is to set your drill on the search for oil and find it."



Tough, colorful, lasting beauty!

Take those pumps and rigs in the oil fields—or those tanks and pipelines in the refineries! Each needs the tough, colorful, lasting beauty that Rust-Oleum provides. If the surface is rusty, Rust-Oleum 769 Damp-Proof Red Primer can be applied *right over the sound rusted surface* after removing rust scale and loose rust. Special Rust-Oleum Oil Field Finishes match the original equipment colors on pumps and rigs—while other long-lasting Rust-Oleum coatings protect costly tanks and pipe lines.

They're specially made for oil field use—tough, flexible, easy-to-use on the spot by brush or spray! They dry to firm, glossy finishes that resist sun, fumes, heat, moisture, weathering, and blowing dust and sand.

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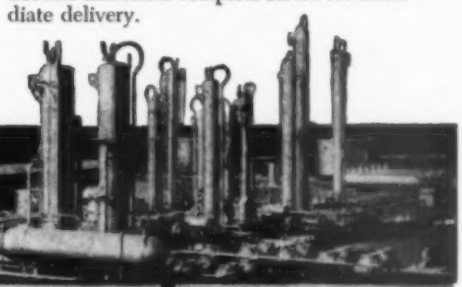
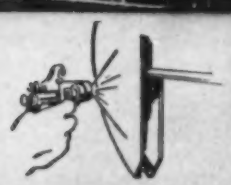


Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surfaces.

Follow-up with the Rust-Oleum finish coating in the color of your choice



By brush or spray — the Rust-Oleum system provides tough, colorful, lasting beauty.

Dries to a firm finish that resists sun, fumes, heat, weathering, and blowing dust and sand.

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THE CONFERENCE TABLE

"Man thinks, therefore he is free."

Management Needs Technology

Did you know that 70 percent of all scientists and engineers for all time are alive today? Does that give you an idea of the technological explosion we are actually living in today? That is what Willard F. Rockwell, Jr. warns about in his article on page A-34. If management fails to understand the technology that is moving so swiftly today, its company will be left in the backwash.

A well balanced management is vital. We were insufficient in the humanities while technology raced ahead, almost unguided it seemed at times. We have bent our effort to learning the management of people. Now Mr. Rockwell reminds management that it must also keep up with science and engineering.

Gives "Magic Barrel" 100 Times

Miss Martha Nance (left) of the offices of Jake L. Hamon, Dallas, Texas, was given an award for presenting "Magic Barrel" over 100 times during the last five years. Miss Mildred Houston, of Pan American Petroleum Corporation, state chairman of the women's program of OIC, presented the award. Miss Nance is the only woman in the industry to have received such an award for participation in the men's program of the Oil Information Committee of the Texas Mid-Continent Oil & Gas Association (formerly American Petroleum Institute). She is an active member of the Dallas Desk and Derrick Club and is currently serving on the Board of Directors.

Professional Status for Engineers

Ohio State University College of Engineering was reorganized. A pre-engineering division for the first two years of pre-professional study was established and a professional division for the last three years of the five-year program. Graduation requirements are based on successful completion of the work of the professional division. Ohio State had already inaugurated a five-year curricula in 1945. The new professional division curricula places greater emphasis on both breadth and depth in the engineering sciences, mathematics, and basic science at the expense of "know-how" courses.

Kings in 100 Years?

Bound economically to politics whether we like it or not, we thought the forecasts for a century ahead would not be complete without some background on government and politics.

J. J. Wuerthner, Jr., our choice as a seer, gives an interesting outlook on Page A-32. This is mainly for the U. S. What about the other countries of the world? Here are some random thoughts — many countries need a cohesive political force and end up with dictatorships of the right or left bobbing up and being thrown out. Why not try a king? A parlimentary king, of course, but one whose court would build some tradition of stability. You'll admit countries that presently have kings are among the most durable. It is said Spain is planning this course. For instance, Cuba could use one right now. Even if it cost a little money, it would pay in the long run. Competition between king and ministers might even hold down the cost of government. A gay court would attract a host of paying tourists.

Whether there are enough kings to go around is doubtful but some of the lower nobility might take king-development courses and learn the job. In 100 years we may have more kings on this earth than we have now.

Texaco Buys Into Experiment, Inc.

Texaco Inc., in an apparent move to strengthen its engineering research "reserves," has traded 19,063 shares of its capital stock for 1000 outstanding shares of Experiment, Inc. Based on stock market quotations on the date of transaction, the trade represents an exchange of $1,539,337. Experiment, Inc., employs approximately 115 research and technical personnel at its Richmond, Virginia, offices conducting research and development in the physical, engineering and chemical fields.

Does the Means Justify?

MANAGE magazine (The National Management Association), claims that at least 75 percent of the 150 major labor contracts to be negotiated this year will probably be accompanied by strikes before final settlements are reached. Stated the magazine: "To a visitor from outer space we must look like a peculiar lot of confused earth dwellers who have learned little from past experiences and historic truths. We have bred, along with a sincerely wholesome and honest people, a special breed whose particular job is to be as untruthful as necessary, or expedient, to advance the thinking and goals of the honest . . . we can't come to terms without exaggerating statements to make our position look more honest."

Watch for Depletion Moves

One hurdle has been passed in the percentage depletion controversy but it is not exactly a time to relax. The Senate rejected an amendment June 25 offered by Senator Douglas (D.-Ill.) which would have provided for a graduated reduction in the present regulation. It was the same amendment that the Senator from Illinois had presented last year. He is only one of a number of determined so-called liberals who have fought to eliminate or reduce the depletion allowance.

40th Anniversary — No Celebration!

Another anniversary — not celebrated — is being marked by the oil industry year: The 40th anniversary of the first state gasoline tax. Oregon attached a 1-cent levy to the price of gasoline in that state in 1919. The tax was quickly noted, and three other states, Colorado, New Mexico and North Dakota, adopted the idea that same year. In 10 years all of the 48 states were taxing gasoline, averaging 3.5 cents per gallon. In 1932 the federal government levied a 1-cent per gallon "emergency" tax. Today, motorists pay an average of 8.9 cents per gallon, including a 3-cent per gallon federal tax — and a current proposal in Washington would raise the rate another 1½ cents!

Highlights ★ ★ ★

Additional Duty for Highway Fund

Congressman Thomas G. Morris (Democrat, New Mexico) introduced a bill early this year which is before the Committee on Ways and Means. The bill calls for an additional tax or duty on petroleum and petroleum products imports. The revenue thus gained would be used in the highway fund for more construction. Morris said the legislation was submitted to eliminate the possibility of additional gasoline tax recommended by the President.

Compromise Rumored on Gasoline Tax

So far the Democratic Congress has held off the 1½ cent boost of the Federal gasoline tax requested by the President. Suggestions persist, however, that a compromise might be arrived at whereby an increase of ½ cent or 1 cent a gallon might be added to the Federal tax. The idea of putting all the returns of this tax into the highway construction program does not seem to be considered. In certain events it could mean an unbalanced budget if this sensible course were taken. Present Federal gasoline tax is 3 cents a gallon.

Bureau Revises Forecast Higher

The Bureau of Mines issued a revised estimate of domestic demand for refined products in 1959 of 9,497,000 bbl per day, an increase of 4.8 percent from 1958. Crude oil production for the last half of 1959 is expected to average 7,295,000 bbl daily — 4.9 percent higher than the same period in 1958. Imports for 1959 are based on the allocations by Oil Import Administration.

For the first quarter, domestic demand gained 7.2 percent. A gain of 5.7 is estimated in the second quarter, 4.5 percent in the third quarter, and only 1.9 percent for the fourth quarter. The downward trend in the percentage gain by quarters in 1959 is due primarily to the general business conditions in 1958, which were at a low ebb during the first half of the year.

Courtesy TIPRO Reporter

New Form of an Old Fad. Over 40 importers have appealed to the Oil Import Appeals Board for increases in their import quotas set by the Administration under the mandatory program. Frequently the Board has determined either no hardship exists or that actual hardship is due to factors not attributable to the program.

Oil Import Quota Raised

Oil import allocations during the six months starting July 1 are fixed at 1,450,362 bbl a day, up a little more than 2 percent from the first half quota. The increase resulted from new estimates of domestic oil needs. The formula used in controlling imports of crude and products is based on domestic demand as predicted by the Bureau of Mines.

Is This a Boom?

Despite optimistic forecasts for 1959, all estimates now look too low. Gross national products for the first quarter of this year reached an annual rate of $467 billion and was about $476 billion for the second quarter. Industrial output in May rose to a record high of 152 percent of the 1947-49 average. This was 6 percentage points above the pre-recession high of 146 last reached in February, 1957. Oil demand and forecasts have been revised to higher increase. The economic picture is better than most of us believe.

Propose Alaska Lease Expansion

Congress is working on legislation to increase the limitation on public land oil and gas leases in the new state of Alaska. The bill would raise the present limits of 300,000 acres to 1 million acres. The Department of Interior approves a 600,000 ceiling. Phil Holdsworth, Alaska Commissioner of Natural Resources, told the committee an increase is necessary to justify oil exploration costs, which are about three times more than in other areas. Most available land for leases is already taken.

Acquires Two Companies

Associated Oil and Gas Company of Houston, Texas, will acquire Timberland Exploration Company, Houston, and South Tex Corporation, Alice, Texas, in a stock exchange involving more than $3 million. Besides producing properties, the purchase will add a gas processing plant and a 75-mile gas gathering system to Associated.

Upholds 50-50 Principle

The Nigeria (Africa) Legislature has passed a petroleum law committing the Federal Government to the 50-50 profit sharing principle. Proved reserves in the three producing fields at Afam, Oloibiri, and Bomu amount to over 100 million bbl. Exports of oil in 1958 total 1,885,000 bbl. The fields belong to Shell-BP. Mobil Oil has also been doing some exploration in the country.

Oil Use Up 25% in UK

Consumption of oil in the United Kingdom increased 25.3 percent in 1958 compared with the preceding year. Fuel oil use was up 52.7 percent and gasoline deliveries increased 15.3 percent. One must remember, of course, that deliveries in 1957 were reduced as a result of the Suez crisis. In 1958 consumption, however, was 23.2 percent over 1956, a good year.

Premier Refining Sold

Negotiations have been completed for the sale of Premier Oil Refining Company, a division of City Products Corporation, of Chicago, to Western Natural Gas Company, Houston. The sale price was nearly $9 million. Premier has three refineries in Texas, pipelines to the refineries, gathering and distribution facilities, producing properties, etc. Paul Kayser, Western president, said these additions would make Western an integrated company.

Good Wells Make Good News

Recent Treatments Engineered With the Aid of the "Frac Guide"

August, 1959

Fracturing is more dependable and effective than ever before -- thanks to the new "Frac Guide*" developed by Dowell. Here are results on four recent treatments that were engineered using the "Frac Guide."

- **Andrews County, West Texas** (Old Oil Well) This well was completed through perforations into the San Andres at about 4300 feet. Production had declined to 25 bopd. Dowell recommended Sandfrac* after engineering a treatment with the "Frac Guide." 25,000 gallons of refined oil carrying 63,000 pounds of sand were injected at 25 bpm. After clean-up, the well tested 107 bopd.

- **Uintah County, Utah** (Old Oil Well) Production from this well had declined to 10 bopd. The pay was the Weber sand from 4180 to 4280 feet. Dowell engineered a treatment using the "Frac Guide" and recommended Riverfrac.* 15,000 gallons of water with 23,000 pounds of sand, F.L.A.* (Fluid Loss Additive) and a silicate control agent were injected down two-inch tubing at 12 bpm. 2½ months later the well was still producing 130 bopd in an area where fractured wells usually drop off to less than 50 bopd.

- **Cowley County, Kansas** (New Oil Well) This development well was completed into a 16-foot section of the Bartlesville sand beginning at 3200 feet. The "Frac Guide" indicated the use of Sandfrac with 10,000 gallons of lease oil, a fluid loss control agent and 30,000 pounds of sand. After treatment the well tested 40 boph on a ¼-inch choke -- 400 to 800 per cent better than other fractured wells in the area.

- **Coke County, Texas** (New Oil Well) This well was completed through perforations into five sections of the Strawn between 6496 and 6628 feet. Dowell engineered a treatment with the "Frac Guide" and recommended Petrojel*. Gelled crude with a fluid loss control agent was injected in three 5000-gallon stages. 22,500 pounds of 20-40 mesh sand were used to pack the fractures created. This well produced 86 bopd on 9/64" choke with a gor of 2000. Comparable wells usually produce about 65 bopd on 9/64" choke with a gor of 3500 to 4000:1.

Take advantage of Dowell's unequalled experience in engineering treatments with the "Frac Guide." There is no additional cost. For service or detailed information, contact the Dowell office or station nearest you. There are more than 165 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma. *Dowell Trademark.

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Dr. Smoley Takes Editorial Post with REFINING ENGINEER

Doctor Eugene R. Smoley

Dr. Eugene R. Smoley, retired vice president of The Lummus Company, international engineering-construction firm, has joined The Petroleum Engineer Publishing Company as Consulting Editor of REFINING ENGINEER.

A 1929 graduate from Massachusetts Institute of Technology, Dr. Smoley had already distinguished himself before receiving his PhD degree. For four years prior to 1924, he was in the technical service group of the N. J. Zinc Company during and following his undergraduate work at MIT. From 1924 until 1927, he was a chemical engineer with the Aluminum Company of America. And, while studying for his doctorate degree, he was an instructor in Chemical Engineering at MIT. It was during these years that Dr. Smoley discovered a method for manufacturing duralumen sheet metal which was free from blisters and slivers. He also conceived the idea of fractional distillation with reflux and still heating for the separation of metals such as lead, zinc and cadmium.

He entered the petroleum industry after graduation in 1929 when he joined the Standard Oil Company of New Jersey, serving three of four years as technical director, Dutch East Indies refineries for NKPM (Nederlandsche Koloniale Petroleum Maatschappij), a Jersey Standard affiliate. Upon his return to the U. S. in 1933, he spent one year with The M. W. Kellogg Company in process design, sales engineering and development work. In 1934, he joined The Lummus Company as a sales engineer, and has served in numerous engineering capacities, including process design, startup operations, sales and development. He was elected a vice president in 1950, and was retired on a part-time consulting basis in the spring of 1959.

For the past six years, he has been a consultant to the U. S. Government, and will continue to do outside consulting work in the petroleum and chemical process industries.

In the 25 years Dr. Smoley served The Lummus Company, he devoted considerable time and effort in the advancement of his profession. He has been, and continues to be active in many of the societies of which he is a member. For the past two years, he has been chairman of the Technical Program Committee of the American Institute of Chemical Engineers. He is also a member of the American Chemical Society, the British Institute of Petroleum, the Society of Automotive Engineers, the American Institute of Chemists, the American Petroleum Institute and the New York Chapter of NOMADS.

He is a member of the Chemists Club of New York, the MIT Club, and the Cosmos Club (Washington, D. C.) He is listed in *Who's Who in Engineering, American Men of Science* and *Chemical Who's Who.*

Dr. Smoley has published scores of technical papers in the chemical engineering field. His doctorate thesis was on "Distillation of Petroleum Hydrocarbons." Other subjects on which he has written include: Cracking of petroleum; distillation; solvent refining of lube oils; economics of cracking; catalytic cracking; outlook studies; and many others. He has authored chapters in technical reference books, including (with B. O. Bowles) "Catalytic Cracking" in *American Petroleum Refining* by H. S. Bell (McGraw-Hill), and "Distillation" in *Science of Petroleum,* Volume 5 by Brooks and Dunston (Oxford Press).

He is president and a director of C. K. Smoley & Sons, Inc., formed nearly 50 years ago by his civil engineer father who died seven years ago. This family publishing firm continues to print "Smoley's Tables," to which Dr. Smoley added 350 pages to the 1956 reprinting, for a total of 1483 pages of engineering data.

Dr. and Mrs. Smoley reside in Scarsdale, New York. They have a son, Eugene Ralph, Jr., a graduate of Cornell University, a daughter, Constance, who is a senior at Northwestern, and their youngest daughter, Margery, 18. His hobbies include golf, hiking and travel, in addition to his continued association with the Petroleum-Chemical Processing Industry he knows so well.

Meetings

Sept. 7-10 — Institute of Management Sciences, annual international meeting, Paris, France.

Sept. 15-17 — Texas Mid-Continent Oil & Gas Association, annual meeting, Rice Hotel, Houston, Texas.

Sept. 16-18—National Petroleum Association, annual meeting, Traymore Hotel, Atlantic City, N. J.

Sept. 17 — Natural Gasoline Association of America, Rocky Mountain regional, Gladstone Hotel, Denver, Colo.

Sept. 21-23 — American Society of Mechanical Engineers, petroleum mechanical engineering conference, Rice Hotel, Houston, Texas.

Sept. 23-24 — Western Petroleum Refiners Association, Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

Sept. 27-30 — American Petroleum Institute, executive committee of board of directors, Greenbrier Hotel, White Sulphur Springs, W. Va.

Sept. 28-Oct. 1 — The American Welding Society, fall meeting, Sheraton-Cadillac Hotel, Detroit, Michigan.

Sept. 29-30 — Western Petroleum Refiners Association, management seminar, Western Hills, Wagoner, Okla.

Sept. 29-Oct. 1 — National Association of Corrosion Engineers, western region, Bakersfield, Calif.

Oct. 1-2 — National Association of Corrosion Engineers, southeast region conference, Jacksonville, Fla.

Oct. 4-7 — Society of Petroleum Engineers of AIME, annual fall meeting, Dallas, Texas.

Oct. 5-7 — American Gas Association, convention, Conrad Hilton Hotel, Chicago, Ill.

Oct. 5-8 — National Association of Corrosion Engineers, northeast region conference, Lord Baltimore Hotel, Baltimore, Md.

Oct. 7-8 — Western Petroleum Refiners Association, annual waste disposal and pollution conference, Broadview Hotel, Wichita, Kans.

Oct. 8-9 — California Natural Gasoline Association, annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.

Oct. 8-10 — American Association of Petroleum Geologists, annual meeting of the Southwestern Federation of Geological Societies, Lubbock, Texas.

Oct. 11-13 — American Association of Oilwell Drilling Contractors, annual meeting, Skirven Hotel, Oklahoma City, Okla.

Oct. 11-15—American Society for Testing Materials, committee D-2 meeting, Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 12-16 — National Association of Corrosion Engineers, south central region conference, Cosmopolitan Hotel, Denver, Colo.

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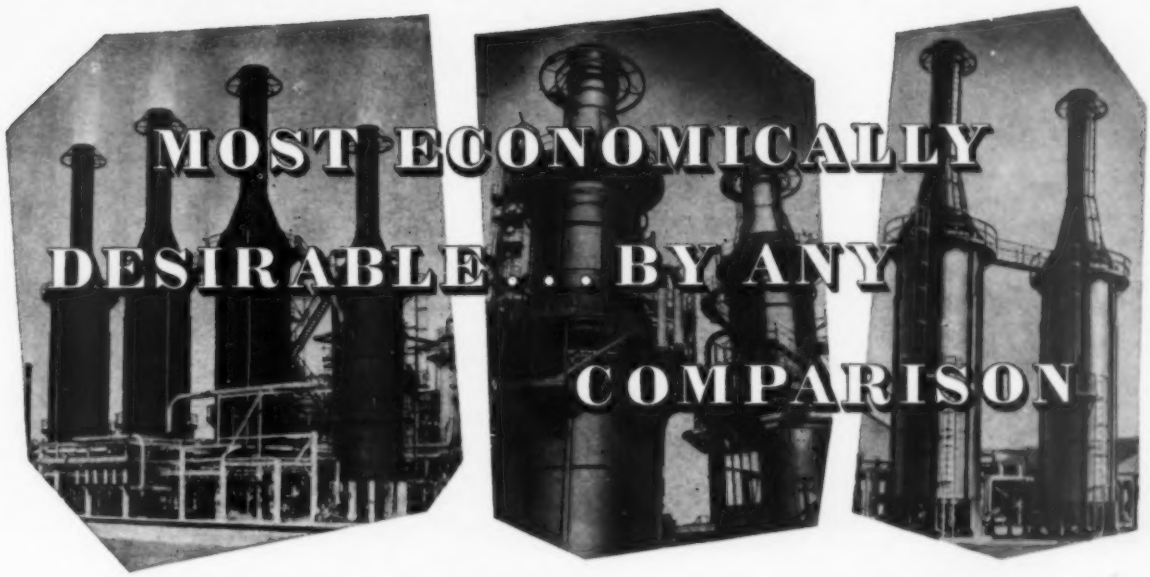

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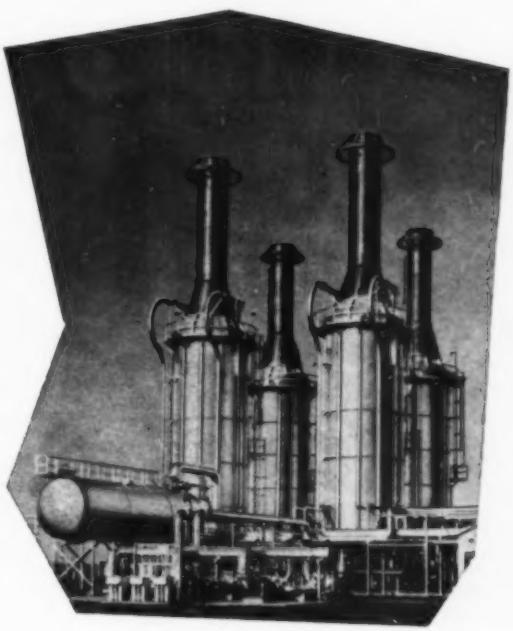

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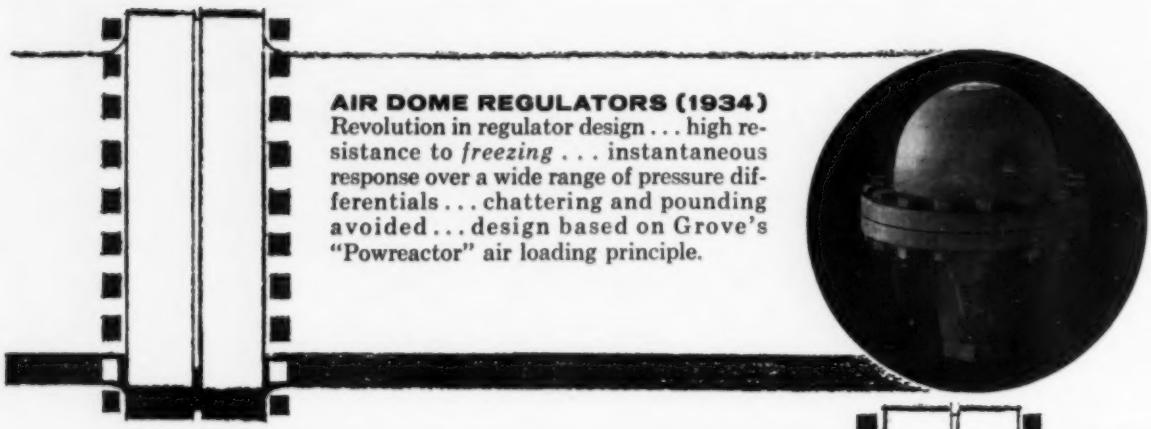

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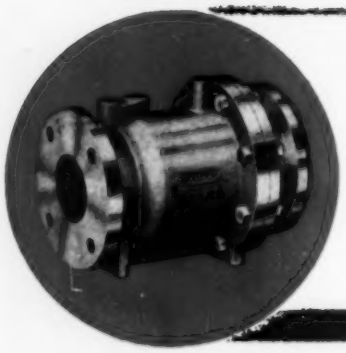

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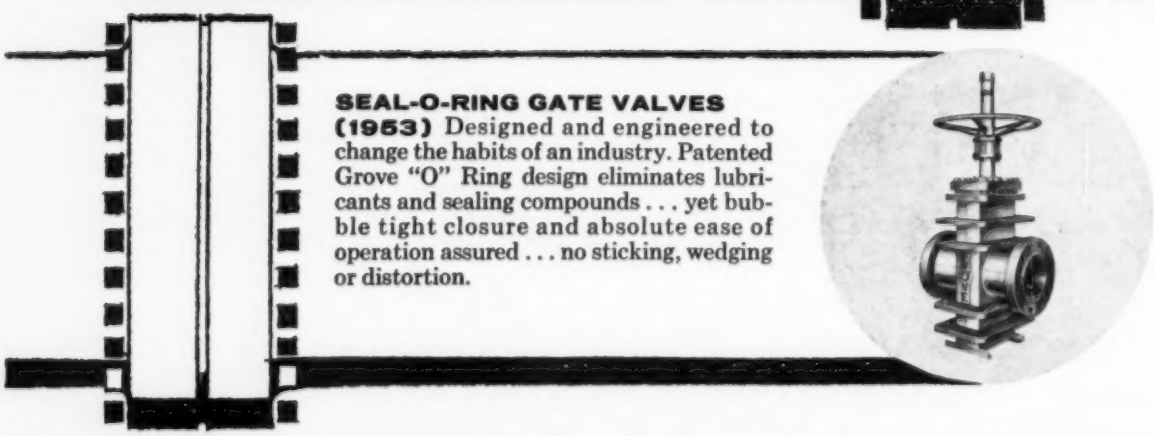

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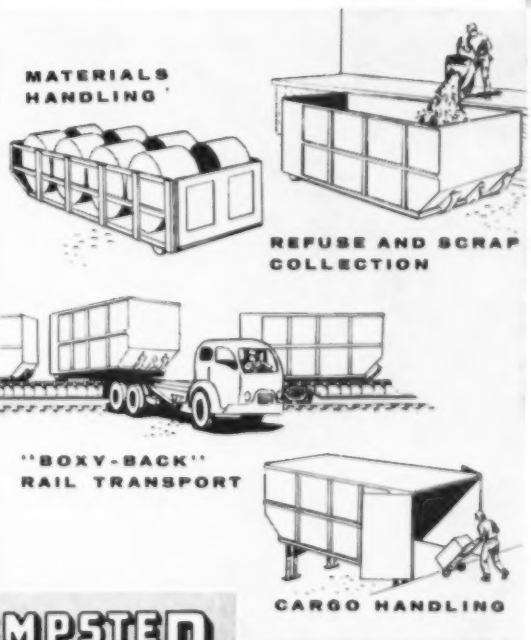

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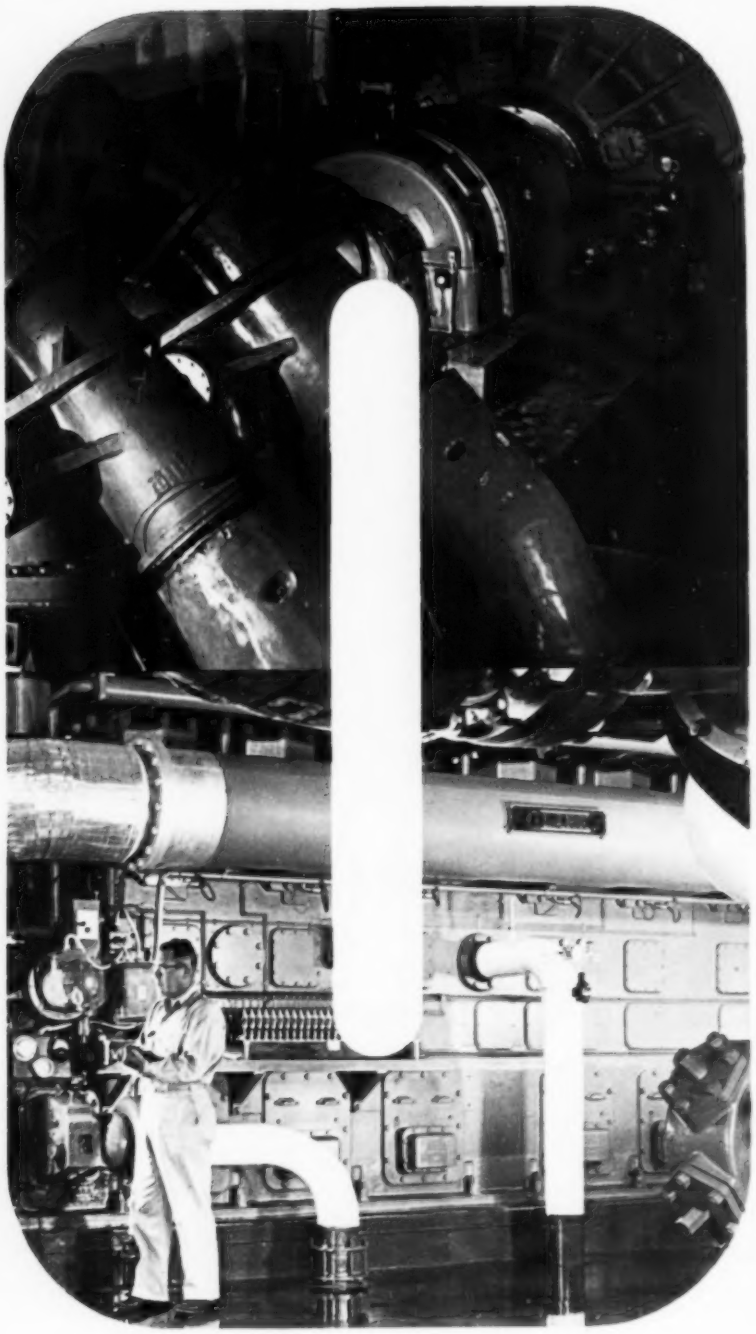

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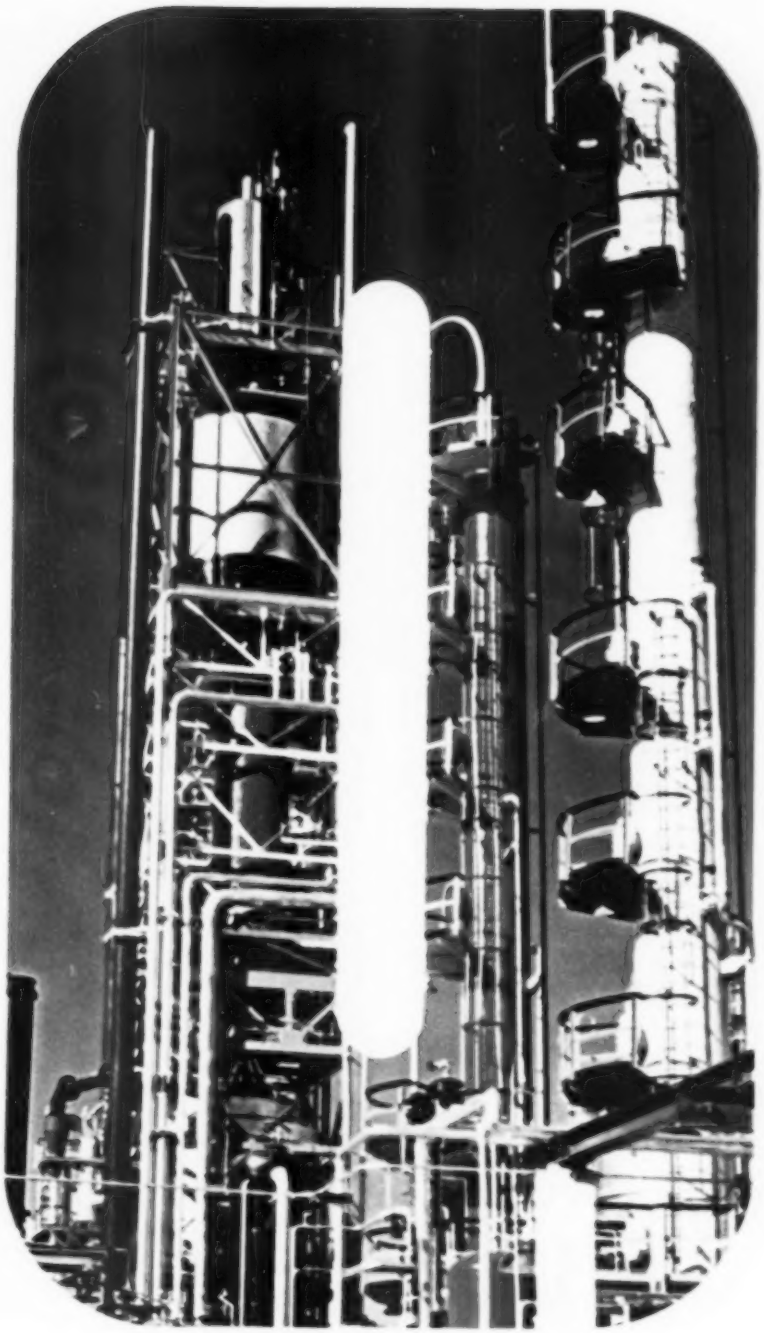

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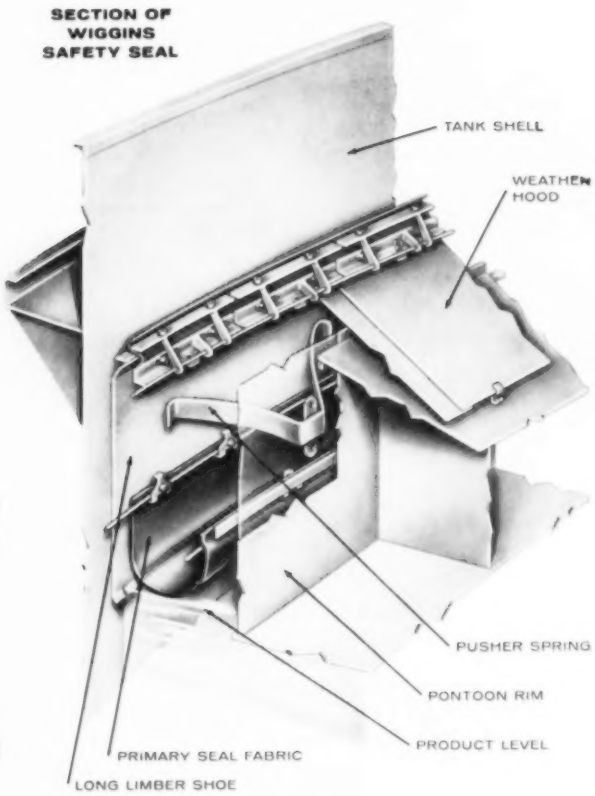

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MANAGEMENT

in the year 2059

"... we have created for ourselves a manner of living in America in which a little learning can no longer serve our needs ..." Nathan M. Pusey

Gilbert C. Jacobus

JIM MANDOR settled down in the lounge of his roomy plasti-dome house after an intensive day at the oil company headquarters. He was responsible for coordinating deliveries and a number of problems had to be resolved.

He was tired and in no mood to do any serious reading yet he knew he had to get more information. The news telecast reporting the loss of the rocket tanker train en route to the interplanetary satellite station emphasized his predicament. Petrochemical reserves at the station had run low jeopardizing their electric power generation. True, they had emergency solar batteries but that would furnish only a small proportion of the power needed. Operations would have to be drastically curtailed unless more chemical stocks were received very soon — might even have to evacuate to Earth some of the local population.

The combustion of fuel to produce electricity directly, instead of producing heat to be used in generating electricity, had been pioneered by a Pennsylvania firm in 1958. They had developed a fuel cell which operated by feeding continuously through a special cell a fuel and an oxidizing agent. These cells, improved, had become competitive with nuclear power and avoided the dangers of radioactivity.

Since there were several sources for the needed chemical supply, Jim wasn't certain as to what his decision should be in relation to stock availability and transport availability. Up-to-the-minute production and inventory reports were needed, together with rocket assembly information.

As he reached for his "thinking-cap" Jim was glad it was no longer necessary to rely on old-fashioned methods of information transfer by personal observation. After positioning the cap, he dialed the company's central computer with the codes to select the production and transportation information needed.

From time immemorial, the natural senses of sight and sound had been the medium for transfer of information to the human brain. But a tremendous breakthrough had occurred when knowledge of the electro-physical functioning of the brain had reached a point of practical application. This was an extension of university research in the mid-twentieth century when scientists first applied electrical stimulation to the brains of rats and cats.

Now, in 2059, audio-visual simulation by means of electric currents made possible the transfer of information from electronic data processing machines to the human brain. Thus in the space of a few seconds, Jim Mandor had in mind world-wide information that in the twentieth century would have required much personal effort and considerable time to absorb.

Increasing Scope of Decision-Making

As he resolved his specific problem of getting an adequate petrochemical supply to the satellite station, Jim Mandor's thoughts turned to the other kinds of problems faced by a major executive in the year 2059. As predicted in 1953 by Frank W. Abrams, Chairman of the Board of Standard Oil Company of New Jersey, business management had continued to enlarge its social vision. Executives had now to be mature in the social sciences to as great a degree as in physical sciences. The electronic "thinking-cap" provided the capability for transferring to the human brain vast stores of information but the development of ability to think and thereby make use of information acquired was still in the hands of university teachers.

Courtesy Architectural Plastics Corp., Eugene, Oregon

"He sat in the lounge of his plasti-dome house," like the one designed by Willard K. Martin, University of Oregon.

A human storehouse of information is not the same as a prudent, mature person on whom society, or a business can rely. People must be taught how to think, how to differentiate degrees of importance, how to predict results with a reasonable range of accuracy as regards probability.

Executive decision-making has always borne the risk of futurity. As time progresses, this risk grows heavier because the impact of executive decisions reaches further into the future. It has been said that the risk of futurity compounds in geometric progression as we reach out further ahead in time in our decision-making. And a business to survive must avoid loss. It must produce enough profits to cover its own risks plus a contribution to society. Social costs will of course largely be met through taxation; but also through contributions by an enlightened management.

When we realize that education, and especially higher education, does much to create and expand markets, the economic contribution of the academic world becomes evident. The other side of the coin is that our intellectual resources and our basic freedoms, so vital to the functioning of our economic enterprises, depend much upon how well higher education performs its task. This creates broad challenge to the academician; it also raises issues for decision now and in the future concerning the kind and extent of support business management should give independent institutions of learning.

The Human Factor

Management development in 2059 will subordinate organizational factors to needs of individual members, although continuing to recognize the place of organizational principles and practices in the scheme of things. Emphasis in the so-called "fusion process"[1] will come to rest on the influence of individuals over organizations.

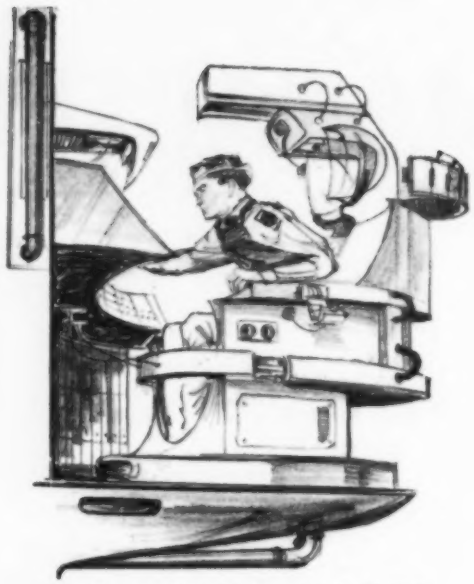
Human values will be pre-eminent. In common with education, industry and government will foster the development of inherent capabilities of individuals to the end that each may make his best contribution as a member of an organization and of society. Great advances in knowledge related to the physical sciences will be coupled with sociological and political advances to create a better life for man within the solar system.

Basic Philosophies and Power Relationships

Research in management sciences will be an integral part of the academic environment fostering identification and development of both the gifted few who produce unusual innovations for progress and the many so-called "average" intellectually who produce the broad base of stability which gives a social system its stamina.

The educational system will be focusing its efforts more on creating an understanding of the meaning and importance

[1]See "The Fusion Process" by E. Wight Bakke, Labor and Management Center, Yale University, 1953.



Reaching for his "thinking cap," volumes of information pertaining to the problem came in from the company's central computer.

of basic philosophies and of power relationships, on teaching people to think, and on improving human accuracy for predicting the future.

A manager's concept of his own roles and the validity of his values will always be a major determinant of his success. A manager must learn to examine, and periodically re-examine, his area of responsibility and his relationships with others in his organization as well as with others he contacts outside the organization. He must see clearly the objectives being sought, both organizational objectives and his own personal goals. He needs to understand the operating philosophy of his organization and the philosophy guiding his own inner life. He has to understand the values governing his activities and associations.

One eminently forward-looking thinker in the field of business administration [2] has put it this way:

"A man's personal philosophy, his way of looking at the world and the men and women around him determine his success as a manager of things and people more than any other single factor. His basic attitudes are far more significant than the techniques he uses . . . As we look ahead, we have reason to believe that this will be increasingly true. In short, the time may come when an evil man or one who has no sense of values simply cannot be an effective administrator."

Power relationships as well as basic philosophies mold human reactions — and all managers wield power. A key problem for a manager will always be the questions of how to use effectively the power he holds. Instinctively we dislike situations where another can use power of any kind to our disadvantage. But in the work situation, recognition is growing that power is affected in a fundamental way by the fact that no manager exercises real authority unless subordinates accept his authority and act upon it. The strategems which a manager finds it necessary to apply if he is to carry out his responsibilities satisfactorily are varied and just about as old as mankind. They'll be around for a long time and will continue to be part of the conscious, deliberate use of power in organizations.

[2]Dean Stanley F. Teele of Harvard Business School as quoted in "Search for a Managerial Philosophy" by D. A. Ohmann, Harvard Business Review, September-October 1957.

The Author

Gilbert Chester Jacobus *is research professor of Public Administration and director, Army Logistics Research, George Washington University, Washington, D. C. He served as consultant in executive development to Federal agencies. His degrees are: Rutgers University, a BS in civil engineering, 1929; New York University Business Administration, MBA, 1935; and Georgetown University, an LLB, 1950.*

Before World War II, Jacobus was with New Jersey Bell Telephone Company. His war service included Intelligence Division of AEF in which he held the rank of colonel. He has received the Legion of Merit, the Order of the British Empire, and many other awards for his work with U. S. forces.

These strategems[3] include such propositions as:

1. When to take counsel.
2. How to establish and maintain alliances within an organization.
3. How much to communicate to whom.
4. When and how to compromise.
5. How to avoid doing something yet not be guilty of obstructionism.
6. What kind of behavior to follow in interpersonal relations.

As in the case of a basic philosophy, the use of power by a manager is a strong factor in accomplishing the ends of the organization, meeting the needs of individuals associated with the organization and maintaining the manager's own position and status. In 2059, even more than in 1959, management development will stress understanding of the role of a manager's basic philosophy and his power relationships.

Ability to Think

In the future, management development will place much emphasis on creating ability to think. Having developed a means for large volume transfer of information to the human brain by electronic methods, it will no longer be necessary to devote valuable learning time to a mere presentation of material for memorizing. This will revolutionize pedagogy, and alter the role of formal education in relation to a man's productive years.

For a long time, although not always officially acknowledged, businessmen have taken the position that employees with only school training have in fact little value to the world of man's work. However, we will find that in the future, more and more integration of the world of work with the academic environment will produce young men and women capable of accepting early in their careers the kinds of managerial responsibilities created by the automated techniques of the future.

Managers in the year 2059 will have to be trained to greater expertness in the decision-making process. Reliance upon traditional subjective methods simply will no longer be good enough. To as great a degree as practicable, generalizations will give way to quantification of relationships.

Mathematical techniques which will be in common use never will produce assurance of specified results in the field of management with all the intangibles to be evaluated. But even in complex, large-scale systems activities, assignment of probabilities based on experience factors develops a more useful basis for assessing the future impact of decisions.

If analysis indicates the chances of success to be one out of three, for example, a manager will know that the likelihood of the desired outcome happening is one out of three, and that the likelihood of failure is twice as great as the likelihood of success. Knowledge such as this eases the assessment of risks incident to selection of a particular course of action.

In the course of present-day Operations Research activities we have well demonstrated the kinds of benefits accruing from the use of numerical values. Situations where this applies involve such problems as determining prices to the customers, selecting a product mix to develop maximum revenue, or relating inventory levels and transportation networks to customer service. Prediction of maximum or minimum results in these cases is essential to good management.

Ability to think a situation through, to sort out factors involved and to define problems in terms of causes rather than symptoms, will become increasingly important.

[3]See Harvard Business Review Nov.-Dec. 1956, "Thinking Ahead" by Norman H. Martin and John Howard Sims.

Courtesy DeSoto News Bureau

Cella I, car of the future is driven by four high-speed electric motors receiving their energy from an electro-chemical power plant.

Research in the management sciences, with assistance from research in the physical and social sciences, will lead the way toward educational techniques that will develop ability to think. Such techniques will be used in both industrial and academic environments.

New Areas for Measurements

Through work that has been done in the field of the social sciences we are now in a position adequately to measure factors such as:

- *Loyalties.*
- *Impacts of goals.*
- *Level of motivation with regard to certain variables.*
- *Degrees of confidence and trust.*
- *Amount and quality of teamwork.*
- *Opinions concerning the effectiveness of delegations of authority.*
- *Opinions concerning organizational use of knowledge and ideas.*
- *Efficiency and adequacy of information flows.*
- *Leadership skills.*
- *Basic philosophies of management.*

Managers of the future will expect and will receive regular reports on their performance as measured by such factors as well as measurements based upon physical attributes such as production volume, labor turnover, costs and earnings commonly used today.

These newer types of measurement will constitute a broader kit of basic tools that managers will have to learn to use properly. Research has indicated that in too high a proportion of instances management procedures cause threatening, rejecting attitudes to arise in superior-subordinate relationships.

As we move further and further into the era of depending upon machines rather than man to accomplish routine mechanical operations, we capitalize more and more upon the human intellectual potential. Capability to maximize an individual's contribution at the intellectual level is directly tied in with ability to hold high that person's sense of importance and personal worth.

A manager's ability to accomplish this flows from right attitudes which are grounded in sound basic philosophies. In the future closely integrated industry-university teams will lead the way in understanding basic philosophies and their impact in the world of economic endeavor, in developing theory and a body of knowledge useful to management, and in pioneering applications that will produce the kinds of contributions society has a right to expect from industry.

In 2059 managers will have to learn to be leaders of men in every sense of the word. ★ ★ ★

A distinguished scientist gives us a well analyzed forecast of supply and demand of petroleum and other energy sources through the coming century

WHERE WILL ENERGY COME FROM IN 2059

Lewis G. Weeks

100 YEARS OF SUPPLIES	United States	World	100 YEARS OF DEMAND	United States		World
Oil (primary)	216 billion barrels	1,900	1959-79	280		960
Oil (secondary)	190 billion barrels	1,500	1979-99	580	(in terms of	2,370
Natural gas	1000 trillion cu ft	6,000	99-2019	1200	billion barrels	5,200
Oil shale	2000 billion barrels	12,000	2019-39	2480	of oil)	11,500
Coal	2000 billion tons	7,000	2039-59	5080		24,000

JULES VERNE'S NOVELS have been referred to as the "Books of Youth." Roughly 70 years ago, when Jules was about my age he prophesied some of the miracles that have since come to pass: Sky travel at 600 miles per hour; submarine traffic; television; use of solar energy, and even a trip to the moon, departing from Florida. Whether or not the editors of *The Petroleum Engineer* felt that I had reverted to dreams of youth, a la Jules Verne, and so was a good candidate for prophesy, only they would know.

However that may be, the progress of the past 70, or even 100 years will be multiplied no doubt many times within the next hundred. I believe firmly that this will come to pass provided that man does not become completely selfish. In that case he stands a chance of sending himself and all his accomplishments into eternity.

Demand Will Multiply

Where will our energy come from in 2059? Some of it will be coming from the same sources it is coming from now. Within another 50 years, however, or shortly after the turn of the 21st Century, other, presently undeveloped sources of energy will have begun to supply an energy demand which will then be **seven or more times what it is today.**

And remember this is only a half century away.

In any forecast of this nature it is necessary to make certain assumptions. It is assumed that there will be no disastrous or catastrophic event or events of natural origin, or of man's own making, which would materially alter the curve trend of energy demand of the past 100 years. On the other hand, it is assumed that the acceleration of the trend will not be significantly greater than that which we are having now.

Existing basic information needed for an energy demand forecast is rather well summarized in "Energy in the Future," by Palmer C. Putnam, Consultant to the Atomic Energy Commission, (D. Van Nostrand Company, Inc., 1953). But for an estimate of sources of energy supply, I have preferred to rely on my own studies. This is particularly true with respect to the fossil fuels. With regard to such sources as nuclear, solar, geothermal, etc., energy, the potential supply is unlimited so far as man is concerned, and there is, of course, no need for an estimate.

This brings us to another basic assumption: That is, that there are no limits to man's ability to find a way to utilize an existing potential resource so long as the need to do so prevails.

He will, if and as necessary, find an economical way

THE AUTHOR

LEWIS G. WEEKS, *one of the greats in geology, knows his world as other people know their backyards. His first job was in Mexico for a mining company right after he received his AB in geology from the University of Wisconsin in 1917. World War I brought him home and he served in Naval Aviation. The war over, young Weeks attended Cornell University and later taught there. He went back to Mexico for a short stint, then to India for Whitehall Petroleum Corporation. In 1924 he joined Standard (New Jersey) and worked in South American countries. He was president of Standard Oil Company of Bolivia before returning to New York headquarters of Jersey Standard where his scope of geological work expanded to cover the globe. When he retired May 1, 1958, he was chief geologist of Jersey.*

Not only has Mr. Weeks an inquiring mind, he has the gift of analyzing and then translating his findings into readable descriptions. His first notable contribution to the literature was "The History of Oil Exploration," written by him and Wallace Pratt in 1939. Another outstanding work is "Paleogeography of South America," published in 1947. He initiated the annual foreign review in the American Association of Petroleum Geologists' Bulletin and for three years wrote the Highlights of foreign activities. He is editor and part author of the 1384-page "Habitat of Oil," a very popular volume of world-wide scope recently published by AAPG.

Mr. Weeks is a valuable member of AAPG, serving in various capacities — as Distinguished Lecturer in 1950, vice president in 1951, chairman of several committees, and today as president of the Association. He is also a Fellow of the Geological Society of America and belongs to American Association for the Advancement of Science, American Geographical Society, AIME, and Geophysical Union.

to recover energy from the vast reserves of low grade oil shales and from thin and deep-lying coal seams.

He will, if he chooses, find a way to harness and transmit solar energy, even from outer space.

He will, if necessary, develop methods for making use of geothermal energy and energy differences within the earth.

He may do the same with tidal energy.

He will learn how to free and utilize more and more the energy of the atom, the sources and supplies of which are beyond our capacity to imagine.

It is a popular practice to base forecasts of demand on estimates of population growth. As a matter of interest we may do the same. From 10,000 B.C. up to about 1500 A.D. this growth was very slow; at times it even reversed itself. Approximately 400 to 500 years ago growth began to gather momentum, first here, then there, and it has been irregularly explosive in its rise since. Annual rate of growth increased from about one per thousand around the year 1500 to about 12 per thousand today.

Population Will Grow 3 Times

In spite of many attempts to explain the causes of population growth and growth variation these causes remain obscure. It seems reasonable to assume that the curve of population growth for the past 200 years will continue the same growth pattern for another 100 years. On this basis we may anticipate a world population of the order of 7 billions by the year 2059, or about 2.8 times the present population of 2.5 billions.

To assume that population will not continue to grow is to disregard the desire of man from earliest time to spread into frontier spaces, and the fact that his ability to adjust an environment to his needs is now rapidly growing. Vast areas, here on earth, are still open to him.

Population increase and an acceleration in per capita demand for energy—particularly in large areas of the world where use today is comparatively limited—will produce a total demand for energy in the year 2059 of at least 40 and probably as much as 50 or more times that of 1959.

TABLE I. WORLD CRUDE OIL AND LIQUID PETROLEUM GAS PRODUCTION, RESERVES, DISCOVERIES AND TOTAL RESOURCES.[a]

(As of January 1, 1959 in billions of barrels)

1	2		3		4		5		6	
Country or area	Cumulative production	% of world	Proved reserves	% of world	Cumulative discoveries[b]	% of world	Ultimate resources[c]	% of world	1958 Prod. million bbl/day	% of world
United States	64.03	56.79	36.0	11.76	100.03	23.89	270.0	13.5	6.7	37.09
Balance N. America	4.33	3.84	5.0	1.63	9.33	2.22	110.0	5.5	0.72	3.99
Total N. America	68.36	60.63	41.0	13.39	109.36	26.11	380.0	19.0	7.42	41.08
South America	14.7	13.04	18.0	5.89	32.7	7.81	196.0	9.80	3.06	16.95
Total W. Hemisphere	83.06	73.67	59.0	19.28	142.06	33.92	576.0	28.80	10.48	58.03
Europe[d]	0.70	0.62	1.3	0.42	2.00	0.48	19.0	0.95	0.24	1.35
Africa[e]	0.02	0.02	8.0	2.62	8.02	1.91	100.0	5.00	0.03	0.16
Middle East[f]	12.83	11.38	200.0	65.38	212.83	50.82	780.0	39.00	4.32	23.92
Far East[g]	3.32	2.94	10.7	3.49	14.02	3.35	85.0	4.25	0.46	2.54
Total E. Hemisphere[d]	16.87	14.96	220.0	71.89	236.87	56.56	984.0	48.20	5.05	27.96
Total Free World	99.93	88.64	279.0	91.18	378.93	90.49	1560.0	78.00	15.53	85.99
Iron Curtain Countries	12.81	11.36	27.0	8.82	39.81	9.51	440.0	22.00	2.53	14.01
Total World	112.74	100.0	306.0	100.0	418.74	100.0	2000.0	100.0	18.06	100.0

[a]Includes both land and water areas.
[b]Column 2 plus column 3.
[c]Oil discovered to date (column 4) plus that estimated to be discovered in the future.
[d]Excluding the USSR and other Iron Curtain countries.
[e]Excluding Egypt.
[f]Including Egypt.
[g]Includes India, Pakistan, Burma, Japan, Indonesia and other countries of Oceania, but not including China, Siberia, etc.

TABLE II. CURRENT PRODUCTION, ESTIMATED POTENTIAL SUPPLIES, AND A FORECAST OF THE NEXT 100 YEARS DEMAND FOR ENERGY.

(All figures are in terms of billions of barrels of oil)

A. United States

1			2		3	4		
						100 Years Demand[d]		
			Potential energy supplies from limited sources			At 20-year intervals		By 20-year intervals
1958 Production					Years supply of energy source at 1958 rate of petroleum production			
Oil	2.4	4.5	Conventional ultimate oil production	270		1959	9.0	14 x 20 = 280
Gas	2.1		Oil produced	64		1979	19.0	29 x 20 = 580
Coal		4.0[a]	Oil remaining	216	48	1999	40.0	60 x 20 = 1200
Wood, water power etc.		0.5	Secondary oil	190	42	2019	85.0	124 x 20 = 2480
TOTAL		9.0	Tar sands	10	2	2039	176.0	254 x 20 = 5080
			Gas	164 570	33 127	2059	360.0	Total 9620
			Oil from shales	2000	444			
			Oil equiv. of coal	16000[b]	3555			
			Oil equiv. of wood, water power, etc.[c]	50	11			
			Total	18620	4135			

B. World

			Conventional ultimate oil production	2000				
Oil	6.6	9.1	Oil produced	100				
Gas	2.5		Oil remaining	1900	209	1959	34.0	48 x 20 = 960
Coal		20.5[a]	Secondary oil	1500	165	1979	75.0	118.5 x 20 = 2370
Wood, farm wastes, water power, etc.		5.0	Tar sands	1100	121	1999	170.0	260 x 20 = 5200
TOTAL		34.6	Petroleum gas	1000 5500	110 604	2019	380.0	575 x 20 = 11500
			Oil from shales	12000	1538	2039	820.0	1200 x 20 = 24000
			Oil equiv. of coal	55000[b]	6044	2059	1730.0	Total 44030
			Oil equiv. of wood, farm wastes, water power, etc.[c]	500	55			
			Total	73000	8241			

[a]One ton of coal plus hydrogen is taken as equivalent to 8 bbl of oil.
[b]Taken as equivalent to 2000 billion tons of coal for the U. S. and 6875 billion tons for the world.
[c]Estimated total for the period 1960-2059 only.
[d]Based on the assumption that demand will increase 40-fold in 100 years for the U. S. and 50-fold in the same period for the world.

Thus, demand for energy will a little more than double every 20 years. (Economic factors that could alter the picture somewhat are noted later.)

The categories of energy supply from limited sources that are considered in this 100-year forecast are listed in Table II, column 2, together with an estimate of the amount of the potential supplies. All figures used in this forecast are in terms of billions of barrels of oil or equivalent. It is preferred to use barrels of oil as a common unit of measurement because oil men, for whom this is primarily written, are much more generally familiar with the term than with British thermal units or any other unit. As Btu values of all fuels vary, it is believed that for purposes of an estimate of this nature a barrel of oil is as good a unit of measurement as any one might select.

Sources of Energy Supplies

Ultimate Oil Supply by Conventional Production Methods. The estimate of 2000 billion barrels of total liquid petroleum from the land and water areas of the world, including 270 billion for the United States, is somewhat larger than the 1500 and 240 billion barrels figures, respectively, which I cited in "Fuel Reserves of the Future," (published in the Bulletin of the American Association of Petroleum Geologists, Vol. 42, No. 2, February 1959, pp 431-441.)

I stated in connection with my early estimates that the figures used were believed to be very conservative. It should be remembered also that those figures did not include the water areas of the world or the liquid petroleum gas, the latter of which may total as much as 10 percent or more of the primary recovery. None of the figures include secondary recovery and its associated LPG.

All of my estimates, as a matter of fact, including the earliest, which were published by others, were made primarily not for publication but for the purposes of quantitatively rating the basins of the world. This purpose only requires that the figures be of comparable magnitude. All of the totals that have been published merely represented in round numbers a summation of the individual rating estimates for the hundreds of basins or basin areas about the world.

Rating quantitatively in terms of oil forces study, analysis and thinking. By this means others know what you have in mind, and a common basis for discussion is provided. This can hardly be said for such noncommittal or widely interpretable classifications as good, fair, poor, or A, B,

TABLE III. ESTIMATED AVERAGE ANNUAL ENERGY USE IN TERMS OF BARRELS OF OIL BY SOURCE CATEGORIES FOR EACH 20-YEAR PERIOD, 1960-2059.

(In billions of barrels of oil)

A. United States

	1	2	3	4	5	6	7	8
	Oil and Gas			Coal conversion to				
20-Year periods	Domestic	U. S. imports	Shale oil	Petroleum	Other forms of energy	Wood, farm wastes, and water power	Nuclear, solar, geothermal, etc., energy	Totals
1960—1979	6.0	2.5	minor	minor	5.0	0.5	minor	14.0
1980—1999	7.0	12.0	1.0	1.0	6.5	0.5	1.0	29.0
2000—2019	6.0	12.0	4.0	10.0	17.5	0.5	10.0	60.0
2020—2039	3.5	9.0	10.0	25.0	41.0	0.5	35.0	124.0
2040—2059	2.0	5.0	15.0	45.0	84.5	0.5	102.0	254.0
B. World								
1960—1979	15.0	2.5	minor	minor	25.5	5.0	minor	48.0
1980—1999	52.5	12.0	2.0	2.0	43.0	5.0	2.0	118.5
2000—2019	50.0	12.0	20.0	20.0	115.0	5.0	38.0	260.0
2020—2039	45.0	9.0	60.0	50.0	250.0	5.0	156.0	575.0
2040—2059	30.0	5.0	100.0	90.0	500.0	5.0	470.0	1200.0

C, D, etc. The comparison with other areas that is afforded by quantitative appraisals is a powerful means of checking up on one's thinking and analysis; and of course there are many other quantitative methods for comparison and cross-checking.

Properly used and not abused, ultimate resource estimates are no more out of place than the hundreds of other estimates that are made in the oil business every week, or indeed in any industry. They need to be revised from time to time as new facts on oil occurrence, both local and general, develop. An analysis of the history of estimation of our "proved reserves" reveals that final realization figures average something like four times the earliest estimates. Perhaps one might question whether ultimate resource estimates, if made successively on a comparable basis, will vary by a significantly greater factor.

For the purposes of a forecast of the nature of the present it is thought that an ultimate oil supply by conventional production methods of 2000 billions of barrels for the world, including 270 billions for the United States, is more realistic than the somewhat lower figure; though to justify them at this stage may stretch the imagination of many of those best informed.

My assignment by the editors of *The Petroleum Engineer* specifically requested an opinion on where the petroleum would be forthcoming. For present purposes, Table I adequately answers this. At the same time it gives a necessary basis for the forecast. Other potential sources of energy supply are the following:

Secondary Recovery. Estimates of 1500 billion barrels of oil for the world and 190 for the United States are thought to be of the right relative order of magnitude. It might be noted that, as time goes on probably more and more of the original oil in place will be recovered by the primary methods.

Tar Sands. Heavy tar sands are widespread. Deposits are huge in several countries. As shown, they are not comparatively large in the United States.

Petroleum Gas. Potential unproduced reserves of petroleum gas are estimated at 1000 trillion cubic feet for the United States and 6000 trillion for the world. For conversion, 6000 cubic feet of gas was considered to have the energy equivalent of a barrel of oil.

Oil Shales. The total amount of bitumen that is locked in the clay and lime muds of the geologic past is fantastically large. However, probably only the richest of these, now lithified muds will be commercially exploitable by any method to be devised, and hence constitute reserves within the next 100 years. Possible potential resources of such shales in the United States are estimated at 2000 billion barrels, and for the world on the same basis, at 12,000 billion barrels.

Under today's economics commercially proved world reserves of shale oil are measured in scores of billions of barrels, but are probably not over 150 billion barrels. A deterrent to the ready development of oil from oil shales is the present unavailability of the very large capital requirements.

Coal. Estimated remaining potential coal resources are of the order of 2000 billion tons for the United States and 7000 billion for the world. To be sure, fully three-fourths of these believed existent quantities of coal do not constitute reserves under substantially present methods of exploitation and economics. There are, for instance, vast deposits of lignite that are not now commercially exploitable. And there are very large amounts of coal occurring in seams too thin or too deep for economical use today, but which will eventually become utilizable by some method such as in situ energy extraction, robot mining, etc.

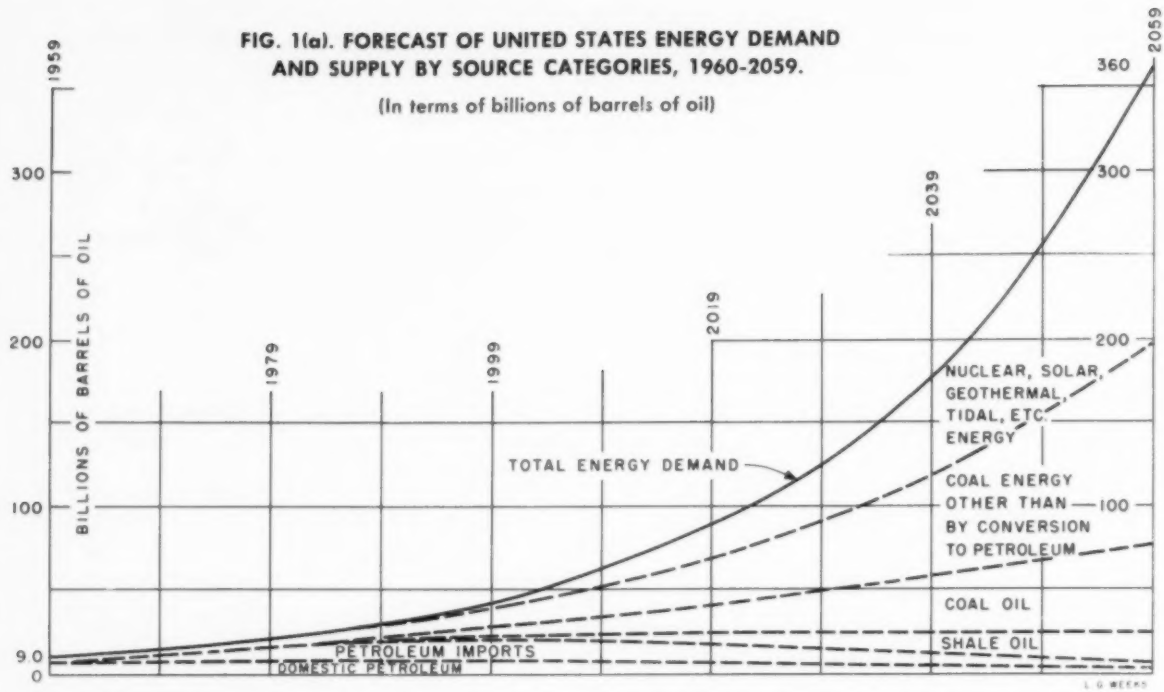
For purposes of this 100 years forecast the figures set up are believed to be reasonably conservative. This is particularly true for the world, for which the figure given may be low by comparison with that given for the United States.

For conversion, an average ton of coal, on hydrogenation, was assumed to be the equivalent of eight barrels of oil. Probably more of the coal will be converted to energy via other means than by conversion to petroleum, and, like much of the oil and gas, some of it will be used for chemical and other products.

Wood, Farm Wastes, Water Power, etc. Up to about 20 years ago more energy was obtained from farm wastes in the world than from hydrocarbon fuels. This fact may be difficult to visualize in a country like the United States. Today, farm wastes contribute between 10 and 15 percent of world energy requirements, or close to three times that provided by wood. While the use of wood and farm wastes

FIG. 1(a). FORECAST OF UNITED STATES ENERGY DEMAND AND SUPPLY BY SOURCE CATEGORIES, 1960-2059.

(In terms of billions of barrels of oil)



will grow a little in some areas, on the whole they will be partly replaced by more convenient forms of energy.

About 70 percent of available U. S. water power is being utilized to provide less than two percent of our energy needs. As water power is usually tied in with flood control and land reclamation projects it generally requires large capital expenditures.

For the United States and the world at large, it is estimated that the decline in the energy use of wood and farm wastes will be roughly offset by an increase in the use of water power. Thus, as in the past 100 years, the total may remain more or less constant over the next 100 years period at around the present rate of use, which represents the energy equivalent of 0.5 billion barrels of oil for the United States and 5.0 billion for the world.

Nuclear, Solar, Geothermal, Tidal and Other Inorganic Energy Sources. Potential supplies of these inorganic sources of energy are practically unlimited. As in the case of oil from shales and from coal, and to some degree also from oil sands, energy from inorganic sources will be relatively little employed for the next 20 or 30 years, and only after 50 years or more will their use begin to assume proportions comparable to that of natural petroleum. The rapid growth of energy demand, however, will need to be met over the final half of the 100 years period predominantly by coal-derived energy and by energy from nuclear, celestial and other inorganic sources.

Among the principal deterrents to the rapid growth in the use of nuclear energy, in addition to the hazards involved, are the capital costs. These costs are some two or three times those for the conventional use of coal or petroleum. Hence, for some time nuclear energy will be used mainly for special situations and special uses on land and sea, uses which do not bulk large in the total energy demand picture.

Development of atomic energy in connection with chemical or other types of production processes will permit a division of capital operating costs. This will no doubt help to bring about a more favorable economics. This characteristic of atomic energy use is one of its auspicious aspects.

A possible use of atomic energy that is contemplated and will be tried is in the recovery of other sources of energy, such as the fossil fuels, by the production of underground heat by means of explosions or by the introduction of atomic wastes into the subsurface formations.

Another inorganic source of energy which has definite possibilities is geothermal. Its utilization may involve the direct use of the internal heat of the earth or of heat energy differences within the earth. This source of energy is used in a few places today where high temperatures exist close to the surface of the earth and there is subsurface water permeability.

Other methods of utilizing the large geothermal sources of energy will no doubt be developed. Temperature differences within the earth could be artificially created by atomic explosions. Utilization of the vast amount of energy that is represented by the tides is also a possibility at some time within the next 100 years.

Potential Supply and Demand

Let us now proceed to set forth the elements of which the picture is composed and paint in the major details.

Fig. 1(a) and Fig. 1(b) set out in graphic form what now appears might be the schedule of energy use by source categories over the century period for the United States and world, respectively. The figures on which these graphs are based are developed in Tables II, III, and IV.

Tables II (a) and (b) give for the United States and for the world, respectively: Recent annual production of the presently used sources of energy; my estimate of the potential supplies available from the limited sources (petroleum, coal, etc.), and a forecast of the demand for energy over the next 100 years. All figures are in terms of billions of barrels of oil, as are also the figures in Tables III and IV and those on which the graphs of Fig. 1(a) and Fig. 1(b) are both based.

In Table II, column 1 we see that out of a total energy use in 1958 equivalent to 9 billions of barrels of oil for the United States and 34.6 billion for the world as a whole, 4.5 and 9.1 billions respectively were in the form of fluid natural petroleum (oil and gas). Coal made up the equivalent of 4.0 and 20.5 billion barrels, and wood, farm wastes,

TABLE IV. SCHEDULE OF ESTIMATED ENERGY USE BY SOURCE CATEGORIES FOR EACH 20-YEAR PERIOD, 1960-2059.

(In billions of barrels of oil)

A. United States

	1		2		3		4		5		6		7		8	
	Oil and Gas						Coal conversion to									
	Domestic		U. S imports		Shale oil		Petroleum		Other forms of energy		Wood, farm wastes and water power		Nuclear, solar, geothermal, etc. energy		Total	
Potential supplies	570				2000				16000		50		∞			
20-year periods		%		%		%		%		%		%		%		%
1960–1979	120	42.9	50	17.9	minor		minor		100	35.7	10	3.5	minor		280	100.0
1980–1999	140	23.7	240	40.7	20	3.4	20	3.4	130	23.7	10	1.7	20	3.4	580	100.0
2000–2019	120	10.0	240	20.0	80	6.7	200	16.7	350	29.2	10	0.8	200	16.6	1200	100.0
2020–2039	70	2.8	180	7.3	200	8.0	500	20.2	820	33.1	10	0.4	700	28.2	2480	100.0
2040–2059	40	0.8	100	2.0	300	5.9	900	17.7	1690	33.3	10	0.2	2040	40.0	5080	100.0
Total used, 1960-2059, and % of total	490	5.1	810	8.4	600	6.2	1620	16.8	3090	32.1	50	0.5	2960	30.8	9620	100.0
Remaining supplies	70				1400				12050				∞			

B. World

Potential supplies		5500			12000				55000		500		∞			
20-year periods		%		%		%		%		%		%		%		%
1960–1979	300	31.3	50	5.2	minor		minor		510	53.1	100	10.4	minor		960	100.0
1980–1999	1050	44.3	240	10.1	40	1.7	40	1.7	860	36.3	100	4.2	40	1.7	2370	100.0
2000–2019	1000	19.2	240	4.6	400	7.7	400	7.7	2300	44.2	100	1.9	760	14.6	5200	100.0
2020–2039	900	7.8	180	1.6	1200	10.4	1000	8.7	5000	43.5	100	0.9	3120	27.1	11500	100.0
2040–2059	600	2.5	100	0.4	2000	8.3	1800	7.5	10000	41.7	100	0.4	9400	39.2	24000	100.0
Total used, 1960-2059, and % of total	3850	8.7	810	1.8	3640	8.3	3240	7.4	18670	42.4	500	1.1	13320	30.3	44030	100.0
Remaining supplies		830			8360				33100				∞			

water power, etc., used amounted to the equivalent of 0.5 and 5.0 billion barrels respectively.

Estimated potential energy supplies from limited sources, shown in column 2, includes, in addition to sources now used, oil shales, which are slightly used abroad, and oil sands. Coal is shown in terms of the oil equivalent by hydrogenation. Column 3 indicates the familiar number of years of supply at the last full year's rate of production. In this case all of the years of supply figures are given in terms of the 1958 rate of production of petroleum (oil and gas), respectively 4.5 for the United States and 9.1 for the world.

A forecast of the energy demand for the next century is given in column 4. On the left in the column is shown the annual demand at 20-year intervals, and on the right is the suggested total energy use by 20-year intervals. These estimates are based on the assumption that energy demand will increase 40-fold over the next 100 years for the United States, and will increase 50-fold for the world as a whole over the same period. This calls for a little more than doubling the rate of use every 20 years for the United States and a somewhat faster rate of increase for the world as a whole. A few words about this rate of increase seem desirable at this point.

Big Factor Is Costs

The factor which, more than any other, could change the rate of increase in the use of energy from that assumed in constructing Tables II, III and IV and the graphs of Fig. 1, is man's ability to make energy abundantly available in convenient form for its many uses at generally acceptable prices. Much depends, in other words, on the extent to which man can afford to be wasteful.

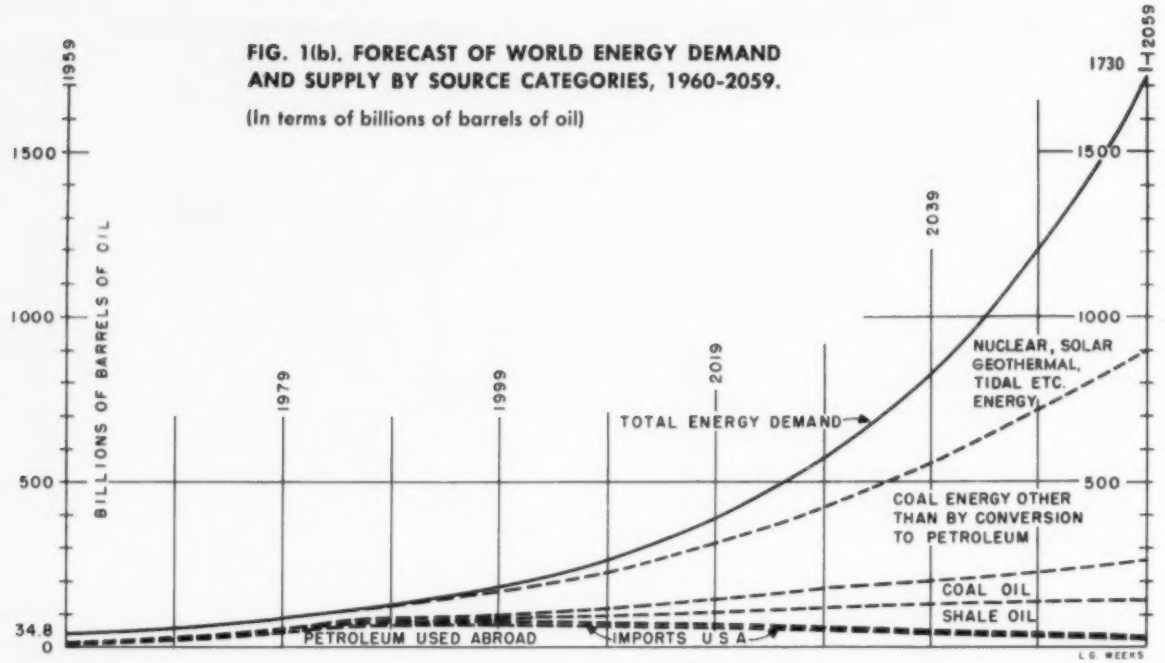
On the one hand, it is conceivable that energy may be made so abundantly and cheaply available as to call forth a much more rapid acceleration of use than I have envisioned. On the other hand, a lesser rate of availability of energy, and attendant increased costs, will be accompanied by a decrease in gross energy use. This decrease will in some degree be offset by an increase in efficiency of use.

In this latter respect, there is much room for developments. Just to mention a few examples: There are our monster, over-powered automobiles; heating, cooling or air conditioning methods and practices of home to city-wide dimensions which are grossly wasteful; clothes and other goods, appliances and equipment that are made to be used and thrown away, to be replaced by new models appearing every year, and so on. These are a few of many instances in a great area which might easily be replaced by a new pattern designed to increase efficiency and save energy.

Tables III(a) and (b) set forth the estimated average annual energy use from each kind of source during each 20-year interval. The totals in column 8 are the same figures already seen in Table II, where they are shown multiplied by 20 on the right hand side of column 4 of that table.

The schedule of total energy use forecasted by source categories by 20-year periods is laid out in Tables IV (a) and (b) for the United States and the world, respectively.

Shown also in each case are the estimated total potential energy supplies of each category with which we begin the 100-year period, and the estimated amounts of these supplies that will be remaining at the end of the century. The percentage of total energy to be supplied by each source



during each of the successive 20-year periods is also indicated.

As previously stated, all of these data are summarized in graphic form on Figs. 1(a) and (b) for the U. S. and for the world.

It will have been observed that in both Table III and Table IV, column 2 is for oil imports into the United States. These imports are also shown graphically on Figs. 1(a) and 1 (b). For purposes of the forecast, for the United States in particular, some estimate of the energy supplied by petroleum imports was necessary. The imports were gradually increased to a maximum average of about 19 percent of world production for the years 2000-2019, and then gradually decreased to an average of about 14 percent over the 2040-2059 period.

No apology is made for any of the estimates of supplies. On the basis of the assumptions set forth at the outset of this forecast, the estimates are considered to be realistic. Anyone is at liberty to quarrel both with the estimates and with the manner in which their use is distributed over the 100 years.

Depends on Technical Breakthrough

What will actually occur will depend on scientific and technological developments and breakthroughs which may greatly facilitate the use of certain of the great sources of energy in ways and to extents that are not now easily predictable. The tables and graphs provide a frame of reference within which anyone may juggle the components in ways that happen to suit his beliefs or his fancy.

With regard to estimates of ultimate petroleum resources, it is felt that the burden of proof would rest heavily on anyone who would like to picture these in a quite different order of magnitude. A lifetime of intense analytical study of petroleum occurrence has empirically demonstrated major factors that control such occurrence. These factors have been repeatedly cross-checked against many hundreds of occurrences and basin situations, and the knowledge that has been amassed has been applied to the geology studied and restudied basin by basin over the world. Considering the total energy demand that we can look forward to over the period, any change in the petroleum supply picture would have to be one of unlikely great magnitude to change materially the ratio of petroleum energy supply to total energy demand from that herein set forth.

A somewhat more rapid discovery and production of the available petroleum could perhaps be effected. However, from a practical standpoint there are numerous factors which limit the rate at which petroleum can be discovered and produced most efficiently, though no doubt new recovery techniques will be developed which will not only enable a speeding up of production but also a greater recovery of the original oil in place, both in total volume and by primary means.

Similarly, some technical experts may envision that more, or less, of the coal supplies will be converted to petroleum, either for use as energy or as petrochemicals. Incidentally, just as today there is usually no separating of the petroleums and coal used for petrochemicals and used for energy, no attempt at separation is made for the period of this forecast.

Petroleum Will Become Chemical Industry

Eventually, the petroleum industry will become in large degree a chemical industry. It will predominate in the new era of petrochemicals. It will contribute to and participate predominantly in the development of plastics and fibers, construction materials and materials used in agriculture. In fact, the oil industry will provide the raw materials and fashion the building blocks for hundreds of products useful to man.

Petroleum will also participate in a major way, we are told, in the great future for nuclear energy, particularly in space travel, astronautic as well as areonautic. It will do this because the elements that make up petroleum are essential raw materials for use in combination with rocket propellants for their most efficient operation. The same applies, of course, to missiles.

So uniquely attractive is the composition and chemistry of petroleum and flexibility of its chemistry, that when natural supplies tend toward exhaustion, it may not be surprising if man finds a way to synthesize hydrocarbons and fashion them to his needs.

Many thousands of times more energy comes to the

"Man stands today in the world of science not far beyond where Adam stood at the dawn of creation. A whole new world lies before us, a world infinitely vaster than ever before contemplated . . . Let us not set a limit on the future because of the past . . . The mere existence of things does not insure their development and their utilization . . ."

earth's surface from the sun than the total of all energy used by man. Scarcely any of this is used because man has not yet developed the means to avail himself of it. A number of schemes for the utilization of solar energy have been investigated or considered. These include—in addition to the more obvious physical devices — conversion of sunlight to electrical energy by various means, including those of photochemical reactions and controlled nonbiological photosynthesis. It is the latter that now appears to have the greatest promise when the means to arrive at the basic reactions are discovered. The conversion of solar to electrical energy will no doubt one day be solved, as will also the facility for widespread use of solar energy for heating, air conditioning and many other purposes. Man will not have to depend only on the energy arriving at the earth's surface from the sun; he will eventually find a way of transferring it to the earth from outer space.

Turning back to the oil industry, there is a great future for secondary recovery, though in the newer fields much more of the oil will be recovered by means of improved primary production techniques. There will be breakthroughs in the techniques of drilling and in reducing casing costs. As these well costs today account for nearly half of the expenses of the producing industry, anything that can reduce them is very important. For one thing it would add to reserves, which is the amount of oil that can be produced economically. While there will be important reserves found by drilling deeper in many places, there are very sound geologic reasons why the total amount of oil to be so added will not be as great as is commonly assumed.

There will be great improvements in the economics of offshore operations through improved techniques. In some areas at present, such as off the Gulf Coast, the large sums spent are scarcely justified. The shelf areas of the world are not to be lightly disregarded, however. The total of all shelf areas in which the prospects range from mediocre to excellent is about three million square miles. This is a total basin area equal to the entire area of the United States.

Capital Will Be Big Problem

Industry will, as in the past, have to meet many difficult problems. One of the most difficult for management in the future will be to find the cash requirements. In this respect the problems of the present are modest indeed. Availability of capital will depend, as now, on a satisfactory return on investment.

Industry will more and more have to contend with competition for the earned dollar. This competition will be between necessary research and expansion on the one hand to meet the country's needs, and wage demands and politics-motivated sniping on the other. In this latter regard, for its own survival and for the good of the country, industry will have to abandon its aversion to protecting itself politically.

One of the country's present greatest dangers is that of pricing itself out of world markets because of the great disparity in costs. In this regard the need for the depletion allowance was never greater. In contrast to the pride taken by most foreign governments in their important big industries, and their jealously protective attitude, even to the extent of encouraging cartels and the use of other more highly nationalistic devices, many politicians have found it politically popular to make it appear that there must be some sort of pernicious evil associated with efficiency and growth in industry.

Far more ominous for the country's future are the ever-growing costs that are being imposed on industry, on governments, local, state and national, and on the people themselves. Their effect is to put the country at a competitive disadvantage, force inflation and mortgage the future of our children and grandchildren. It is evident that with all that industry has done to increase efficiency there is a limit to how much of these costs can be offset. Some of them will have to be met through the use of automation.

More Research Needed

The petroleum industry will need to accelerate its research to keep abreast not only with intra but inter-industry competition. In few other industries are the rewards to be anticipated as great as they are in the petroleum industry.

More attention needs to be given to basic research, either by the oil industry itself or by subsidies at research institutes, universities, etc. It is well to remember that all our wealth, all that man possesses in the world today, has resulted from some basic discovery in the past. There also needs to be a more realistic attitude toward those in research to get the most for the research dollar.

Man stands today in the world of science not far beyond where Adam stood at the dawn of creation. A whole new world lies before us, a world infinitely vaster than anything ever before contemplated. Each successive generation will see more advance than the two preceding. What has seemed silly has usually been the first intimation of some new development. Let us humbly remember that most of our greatest scientists, inventors and teachers alike were ridiculed or held up to contempt, even crucified.

Let us not set a limit on the future because of what we have known in the past. The only reason that we have to worry about the future is to do something constructive about it. There is a lot of future to worry about, when we measure our own lifetime against that of human history, and human history against geologic history, and geologic history in turn against that of astronomy. But if we worry in the right way we will find our frontiers becoming ever vaster.

Man's greatest resource is his mind and his capacity for research. The mere existence of things does not insure their development and their utilization. Man lived for many thousands of years among vast potential resources without doing anything with them. What we see as resources were not resources to our ancestors, and the same will be true with respect to us. For anything to become a resource man must attain a culture to utilize it. As long as man's culture, his capacity for basic research, has healthy growth, his resources are bound to grow.

And so I close as I began. Man will continue to spend billions on fathoming the secrets of nature and in building machines to utilize the forces. Unless he spends much more effort than he does today in fathoming himself, on learning the secrets and potentialities of the human being, there is more than an even chance that a wrathful Providence, in resentment of man's misuse of his bounty, will once again decide to let him live out the next 2000 years in the misery and mess he has created. ★ ★ ★

What Will Politics Be Like in 2059?

**Communism will disappear . . . to be replaced by terrestial issues . . .
Voters will participate in elections through electronic devices . . .
Biggest danger, as now, will be ourselves**

J. J. Wuerthner, Jr.

THIS YEAR OF 1959 has special significance because it is the petroleum industry's centennial year. Undoubtedly Colonel Drake could never have imagined the fabulous industry that started when he brought in the world's first oil well near Titusville, Pennsylvania, in the search for a fuel to replace the scarce whale oil for the lamps of that era.

The America of 100 years ago was young, dynamic and struggling to strengthen itself. Yet, the political problems of 1859 were, in many respects, quite like the troubles we find today. Before launching into the unknown with predictions of the political situation for 2059 when the oil industry begins its third century, let's turn back the pages of history for a quick look at the American scene when the oil industry was born, and contrast the situations with those of today.

In the national political scene, President Buchanan's Congressional Democrats were beaten in the elections, losing to the newly-formed Republican Party. It's not much different 100 years later with President Eisenhower's Republican Party losing the 1958 Congressional elections to the Democrat Party. Today, there's talk of a split inside the Democrat party between the North and South, yet a look at history a century ago finds an Alabama politician, William Yancy, organizing the League of United Southerners, formed to purge the Democratic Party of candidates who wouldn't support Southern demands.

Many Demands 100 Years Old

In comparing the Congressional issues of today and a century ago, many of the same demands emerge: More public works projects to pump-prime business, and the opposition view holding for economy to check the mounting national debt. Messages from the White House — a century apart — were warning Congressional leaders that government spending is not the way out of a recession. Familiar sounding complaints came from the newspaper columns 100 years ago including editorial complaints about the decline of the dollar and rising prices.

One of the biggest political issues a century ago, as it is 100 years later, revolved around the relations between whites and Negroes. In both cases Supreme Court rulings came under fire. A century ago the Dred Scott decision by the Supreme Court was being disputed, with the nation torn apart a year later in a civil war over the issue of slavery. Today, a century later, the American people find themselves again in dispute on the racial issue of integration, with present-day arguments containing a ring of familiarity with those 100 years ago.

Although political patterns have changed somewhat in the last century, mainly because of the impact of mass campaigning means and speedier communication, politics still remains the traditional American way of organizing people in orderly (sometimes disorderly) groups to govern themselves. Politics has been, and will continue into the 21st century as an intensely personal process in which those participating come to grips with the best and worst diversities of human nature.

In 2059, the American voter will still be seeking to strengthen our free way of life with only a measured amount of government control necessary to preserve our moral, spiritual and economic way of life.

A century hence, politics and government will remain inseparable, and both activities will still be affecting many facets of the business community, our families, and each of us in our personal lives.

One political shortcoming will be a certainty in 2059 — we will still find voters professing no party allegiance, those calling themselves "independents" or talking of politics as

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His political experience ranges from precinct campaigning to the national scene as assistant public relations director for the Republican National Committee in the 1956 campaign.

Wuerthner developed a public affairs program for General Electric in Syracuse which won the only 1957 award given a corporation by the American Heritage Foundation. He served as chairman of the group which developed the pioneering Syracuse Seminars on Practical Politics; and this Syracuse Plan has been recognized by awards from the Freedoms Foundation at Valley Forge, the U. S. Chamber of Commerce, and the American Public Relations Association. He is the author of the current business best seller, "The Businessman's Guide to Practical Politics," *published in the spring of 1959.*

A native of Great Falls, Montana, Wuerthner was graduated from Montana State University and has a master's degree from New York University.

non-partisan — which is usually non-participation — and generally holding themselves above the fun, excitement, and drama of one of the greatest personal adventures ever conceived by mankind. A century from now the advice of Teddie Roosevelt that *"you are not going to overcome evil by one spasm of virtue"* will still hold. And his appeal for partisan action in politics — and it must be partisan to be effective — will apply with equal vigor:

"It ought to be axiomatic in this country that every man must devote a reasonable share of time to doing his duty in the political life of the community. The first duty of an American citizen, then, is that he shall work in politics. If you are too timid or too fastidious or too careless to do your part in this work, then you forfeit your right to be considered one of the governing and you become one of the governed instead — one of the driven cattle of the political arena."

What of political parties a century from now? My guess is that they will remain vast and complex mechanisms for self-government, varying from state to state and even within the states, and appealing in some fashion to the members regardless of their ideological span from the extreme right to extreme left. Splinter movements, both within and outside of the basic two-party structures will be found a century from now; but my forecast is that party organization will not be markedly changed.

A trend of several decades has emerged, however, that could have profound political repercussions in 2059 — the fallacious idea that government in and of itself can be all things to all people. The demagogic politician will still be promising that only government can solve the voters' problems. The force of politics in the years to come will decide whether a century from now the American people have moved forward into undreamed of era of advances in all areas of our society; or whether the people of this nation have surrendered to the false expectations of the something-for-nothing socializers.

Slaves of Centralized Economy

Unless a new crusade, which returns to the basic tenets of American constitutionalism, arises in the years ahead, the voters may find themselves pauperized and slaves of a centralized economy, geared to collective mediocrity which will have swept away and completely destroyed our freedoms.

Will the American voters, of which only 60 percent of those eligible voted in the last 1956 Presidential campaign, still be staying away from the polls in such numbers in 2059?

My prediction is that nearly every eligible voter will be participating because some type of electronic voting device will be used to cast and record the votes instantaneously, far away from the traditional polling places.

What issues will confront the voter of 2059? Foreign policy problems will have been replaced by terrestial policy problems.

Man's feeble attempts to penetrate outer space in the middle of this century, will become so successful that they will result in new cosmic issues and the politicians will be exploiting such situations to the full measure of their vote-getting potential.

The international Communist conspiracy, dedicated to the goal of world domination, will no longer be a political issue in our society or the world because it will have been crushed by the flame of freedom inherent in all human beings.

A new force which attempts to muzzle freedom and independence will have sprung up among us.

Do you recall the prophetic warning uttered by the man who became one of our immortal Presidents a few months following Colonel Drake's oil discovery in Pennsylvania? Said Abraham Lincoln:

"At what point shall we expect the approach of danger? By what means shall we fortify against it? Shall we expect some trans-atlantic military giant to step across the ocean and crush us at a blow? Never.

"At what point, then, is the approach of danger to be expected? I answer, if it ever reaches us, it must spring up among us. It cannot come from abroad. If destruction be our lot, we must ourselves be its author and finisher. As a nation of freemen, we must live through all time, or die by suicide."

The biggest danger we face in 2059 arises from the inaction, laziness, disdain and "hands off" attitude of our citizens toward the challenge and responsibilities of our representative form of government and its practical exercise — which is politics.

Freedom, in 2059, as well as 1776, or 1959 cannot be created by any government. It cannot be continued by government, because the basic foundation of our political system is that government is the servant, not the master of the people. When political participation is neglected, when we fail to keep alive the ideal of freedom and flexibility of choice on which our competitive enterprise system is based, then we have forfeited our traditional rights. Freedom is then ripe for destruction.

Our danger as Lincoln said, "must spring from among us."

Leaders of the business community will be called on in the years ahead to give the American people a renewed understanding of freedom and our constitutional principles. The same spirit of pioneer action which has cleared away man's ancient physical slaveries and unfolded a technical explosion in our lifetimes unmatched in all history — these business trademarks of imagination and incentive, boldness and reality, sweat and ingenuity — there are the ingredients to be brought to bear in the years ahead to politics and political parties.

Politics is the means which moves the vehicle of democracy forward, and remains the insurance against revolution and tyranny because through politics we can change, improvise, improve and eventually fully liberate us from the enslavement and restrictions that stunt mankind.

American Dream Will Live

Freedom is an unlimited horizon, moving like quicksilver through the thoughts of man. I'm confident that by 2059 the American people will not have neglected the responsibilities which go hand in hand with freedom and that the American dream will continue to be a reality.

One of the finest statements ever made on the need for politics by Elihu Root will still be fresh and unspoiled a century from now:

"Politics is the practical exercise of the art of self-government and somebody must attend to it if we are to have self-government; somebody must study it, and learn the art, and exercise patience and sympathy and skill to bring the multitude of opinions and wishes of self-governing people into such order that some prevailing opinion may be expressed and peaceably accepted. The principal ground of reproach against any American citizen should be that he is not a politician. Everyone ought to be."

American politics in 2059 will still remain the great human experiment in modern history — creating the vision, the exercise of fundamental rights, the patriotism and the religious faith of our Divine Creator's destiny for us, all pointed toward the lofty ideals of freedom, justice and peace.

Another century of glorious opportunities for self-government lie ahead. ★ ★ ★

Management's Most Urgent Problem

Willard F. Rockwell, Jr.

A STORY of President Lincoln might set the stage for my subject. When General Joe Hooker, rushing headlong into battle, was reporting his progress with some measure of unbridled pride, he dated his dispatches, "headquarters in the saddle." Lincoln commented "Trouble with Joe is that he has his headquarters where his hindquarters ought to be."

I sometimes think that we, too, have our headquarters where our hindquarters ought to be. I fear we are 180 degrees out of phase with reality. I fear the dimensions by which we measure our progress are out of kilter with the facts.

I speak of the exploding technology that is forcing new dimensions in management development upon all private and public enterprise . . . whether management knows that these new dimensions exist or not. And I fear too few of us know they exist.

Now, what specific form do these new *management* dimensions take? I submit that technology, the substance from which you and I fashion our bread and butter, makes up the *new* dimensions for management development. Technology is *insisting* itself into human affairs today.

Another story will illustrate that. The impact of technology was being discussed by a group of professional men. The surgeon in the group said that the Bible says that Eve was made by carving a rib out of Adam. "This proves," the surgeon claimed, "that surgery is the oldest profession." The engineer came back quickly, "Not at all," he said. "An engineering job came first. In the six days the earth was created out of chaos." "Yes," said the politician, "but who do you suppose created the chaos?"

Now, let's establish a frame of reference. First, I speak to you basically as a technically-oriented business man.

Our company punches, bends, shears, machines, fastens and finishes metal into bits and pieces to control power of many kinds.

Second, each of us shares something in common. One hundred years ago, neither you nor I could have had jobs anything like the jobs we have today. In our lifetimes we have moved literally from the "good old days" of the horse and wagon to the era of space satellites. More so than any of the thousands of generations that have preceded us, we glibly accept today's progress and regard it as habit tomorrow. In the last 25 years, we've made household words out of television, polyethylene, penicillin, neutron, and so on. We never saw such words in newspapers and magazines when you and I were kids.

Today's children show the impact of technology, even in their conversation. I'm reminded of the two first-graders who were standing outside of school one morning. "Do you think," asked one, "that thermonuclear projectiles will pierce the heat barrier?"

"No," said the second, "once a force enters the substratosphere . . ."

Just then the school bell interrupted. The first kid said: "There goes the bell. Now we've gotta go in and string those darn beads."

In the year 150 B.C., Hero of Alexandria wrote the earliest known record of man's idea that the expansion of water vapor could be harnessed to do work. Yet the first substantial application of this knowledge to a working device did not occur until 1663, some *1800* years later. Management, such as it might have been, went unchallenged for 1800 years by this simple technology. Which of your companies would wait 1800 years between disclosure of an idea and reduction to practice?

Some of the beginnings of my own corporate family can be traced to men who figured out a better valve or a better control that they could buy somewhere else at the time. Driven by the enthusiasm of the inventor, these men struck out on their own, entering our free enterprise system as entrepreneurs. All they needed *then* was a banker and a salesman. Inventor, banker, and salesmen sometimes were all wrapped up in one man, a man who had something of a missionary's zeal in his soul, too. Sometimes this combination of talents required two or three men.

My point is that management decisions then *were based purely and simply on imagination, guts and a little technology. Even as late as the 1920's, technology stood still long*

From a speech to American Power Conference.

The Author

Willard F. Rockwell, Jr. *a graduate of Pennsylvania State College, has been a director of Rockwell Manufacturing Company, Pittsburgh, since 1940, and president since 1947. He became vice president and controller in 1939 and, after World War II service as a captain in the U. S. Army, he returned in 1945 as vice president and general manager.*

Rockwell has been a leader in U. S. industry centers because he has dealt as enthusiastically with ideas as with products.

---

enough for a corporate entity to sprout, take root and flourish.

But technology began demanding more physical and financial resources from management than the small entrepreneurs could muster alone. They soon found consolidations necessary for basic financial reasons . . . reasons based on the need for capital formation to keep pace with the technology exploding around them.

World War II brought technological dimensions of different emphasis to management. With terrifying incentive, we produced guns and tanks and planes in *quantities* beyond the most optimistic predictions of the nation's optimists. Our achievements were as much in terms of *quantity* as of *quality* in technological advancement.

The conclusion of World War II rang down the curtain in the United States on what was the greatest technological and production effort man had known up until that time. Self-denial of consumer products during the war had produced mountainous deferred demands in the general public. So we turned radar into television. We turned automatic tank transmissions into Dynaflows. And we turned atom bombs into nuclear power.

And then we discovered that we still couldn't open the windows on railroad cars, we air-conditioned the whole train!

The pent-up consumer demands of World War II have not subsided. They've merely established a plateau from which our standard of living continues to rise. Today, we find ourselves in the middle of a continuing technological explosion spurred by a Cold War and abetted by our habit of expecting technological breakthroughs almost daily.

Today, obsolescence closely follows invention. While the steam locomotive survived the introduction of the diesel for almost 30 years, the commercial turboprop air transport has survived introduction of the commercial jet by only three years. Television became a near-universal household fixture in the United States within 5 years after commercial introduction, though the telephone probably took 50 years to gain comparable acceptance.

In industry, perhaps the chemical people are more aware than anyone of these new dimensions that technology forces on management.

New chemical plants must pay out in three or four years for the simple reason that production techniques or the product itself probably will be outmoded in that short time.

Technology Engulfs Us

Unfortunately, perhaps, our technological explosion is *irreversible*. For one thing, we can't *dis-invent* anything. The automobile is here to stay, in one shape or another. And try as we might, we can't undo plastics. We couldn't slow down the rate of technical development, even if we wanted to.

To paraphrase poet Robert Browning, progress is the distinctive mark of mankind alone. As long as man exists he shall seek after and applaud that which is new.

You sense the snow-balling impact that technology is making on society within our lifetime as compared to its meager impact on our ancestors of only a few generations ago. Our exploding technology irrevocably and increasingly engulfs us.

Now, I use this term "exploding technology" for a specific purpose. You know, I'm sure, that our most alert and perceptive sociologists are alarmed today about exploding populations. They report that the earth's population is currently increasing at least 30 million per year, *net*. In the United States, we add 2½ million people a year. Rising birth rates and falling death rates will *increase* world population by *152* percent (that's the increment of increase . . . 152 percent) in the next 50 years whereas the increase from 1900 to 1950 was 55 percent. That is, 55 percent vs 152 percent. In other words, the present world population will jump from 2.5 billion to 6.3 billion in 50 years . . . the lifetime of our children. The social and economic problems that follow from this population explosion are obvious. But where does technology and its explosion fit?

We've achieved 90 percent of our technical progress in the last *100* years. In 100 out of 5100 years of recorded history, we've gone 90 percent of the way in 2 percent of the recorded time. What will we accomplish technically in the coming 100 years? What will be the rate of progress per year? How many people will be involved? How many management people are basing today's decisions on dimensions of these proportions?

Management decisions we've been told, must take account of human values. We technical people have been told for quite a few years now that we don't ply our trade in a vacuum. We have been told that human values accompany our technological deliberations. I think we all agree. We agree that a forward step is taken every time a humanities course is added to the technical curricula of our colleges. We're happy when our technical people in industry take management training courses in the area of human relations. We technical people generally agree that a bit of exposure to the humanities is a good thing for us.

Certainly, technology and the humanities exist together. They co-exist, if you will. While it might have been the fashion some years ago to say that technology was the mortal enemy of all honored human values, most people today realize that culture is compatible with indoor plumbing, that humility can be practiced in skyscrapers as well as in log cabins, and that fundamental human values *can* be preserved in a technically exploding society.

Yet, social progress has lagged behind technical progress. Technology has thrust problems on us before we were ready to cope with them in human terms.

We have all heard it said social progress lags behind technical progress because the technical elite . . . the scientists and engineers . . . do not appreciate the impact of their work on civilization, on the social structure of society, and on man as a social animal.

Such technical progress has been defined some times as that state of human development where man pays a laundry to destroy his shirts and collars.

This kind of progress, you see, is what led to the demand — and rightfully so — that engineers study history, philosophy, human relations, public speaking, writing, and a dozen other "humanizing" and enlightening subjects.

Politicians Need Technical Knowledge

But the *fact* is that engineers are but one element in managerial echelons. The overwhelming number of major *political* questions at every level of government are held by people with legal or general business background. Few are technically trained or oriented. For every Herbert Hoover, we

have thousands of non-technical people attempting to make high-level business, political and social decisions without any realistic awareness of the technology exploding around them.

I don't believe that management people in business or government can make sound decisions without having a far greater understanding of the meanings of technological progress than most of them have today. Comprehension of our technological explosion is a prerequisite to intelligent decision-making today.

Right now, one could make up a surprisingly large list of companies on the New York Stock Exchange who have fallen behind, simply because their managements have not had the technical wisdom to evaluate the impact of specific technological developments in their own or related industries. In the case of government, the troubles arising from lack of adequate evaluation are obvious and they need no elaboration by me.

I don't mean to say that all people in management must have a degree in one of the scientific or engineering disciplines. But I *do* mean to say that all management people must have more than a man-on-the-street's background. Actually what management needs is a *feel* for things technical . . . a new mental dimension for technology.

Perhaps I should say that management people can least afford to be anti-technical. Management must learn what kind of information to demand from those who are, by training and background, technically qualified to supply it. Management must then have the ability to evaluate, make judgement, and act upon the technical information supplied.

Policy-making cannot be done successfully in a technical vacuum.

In fact, let's return to the widely accepted, modern concept that *technical* people should have some formal training in the *humanities*. I submit that we play *turnabout* and *insist* that our *non-technical* management people . . . presumably knowledgeable in the humanities . . . be exposed to formal college-level survey courses in *technology*.

I submit that every one in responsible management of corporate or government enterprise should be exposed, at the very least, to a thorough-going survey course in basic patterns of technology. Such a course should be added to the business administration, law and financial curricula of our colleges. Because our technological explosion is upon us, we can't afford to wait for today's college students to reach professional maturity. Post-college courses should be developed for present management people.

Indoctrination Is Urgent

With all due respect for the invaluable management development programs of the several management associations, with due respect for the technical reporting of our contemporary journalists . . . **I submit that a more rigorous formal program for** *technical indoctrination* **for management is urgently needed now. Management must be brought out of the Technical Dark Ages.**

You know, a self-made businessman got up and talked at length about how thankful he was that he had never come in contact with the influence of any schools, colleges, or universities. He admittedly had no education and was proud of it.

When he finished, some engineer in the group asked, "Do I understand you to say that you are thankful for your ignorance?"

"You can put it that way," was the answer. "Why?"

"Oh," said the engineer, "I just wanted to point out that you have a great deal to be thankful for."

Knowledge of human values was sufficient for management when all it had to cope with was the application of human and animal muscle power. Even 100 years ago, technology had very simple connotations. Getting back to Abe Lincoln, there's the story about his taking a sack of grain to a miller who was supposed to be the *laziest* man in Illinois. After watching the slow progress being made, Lincoln wearily said. "I could eat that grain as fast as you're grinding it." "S'at so?" said the miller. "How long could you keep that up?" Lincoln replied, "Until I starved to death."

Management decisions were easily made in the days of Lincoln. But management today and in the future must frame its decisions in terms of jet power, nuclear energy, electronics, fuel cells and intricate chemistry. Data no longer reach management in terms of numbers of slaves, or head of cattle, or hogsheads of tobacco. Today, management gets reports in terms of throughput, neutron flux density, and value analysis.

Data for management are digested through punch-cards, magnetic tapes, rotating memory drums, read-in and read-out devices and finally emerges bearing little resemblance to the physical situation it represents. Data are masticated a dozen different ways before it reaches policy-making levels.

We're told that the sum total of human knowledge, in our day and age, doubles every 15 years. This thrusts more and more *new* material on top of the existing material that every executive hopes to catch up with some day. And our data-processing computers keep piling up more and more ancient history about yesterday's operations and tomorrow's possibilities. Management is falling into Technical Dark Ages.

Who is to take management out of its Technical Dark Ages?

On one hand, industry people who are top management or close to top management should sound the alarm to their non-technical counterparts.

Educators can help. Cross-breeding between the departments of an educational institution is the very solution to the long-range aspect of this problem. Why not a survey course in technology for the Law School, the Business Administration School, and I dare say the Divinity School?

The survey course for non-technical people could span the history of man and the corresponding history of technology.

It could underscore the relationship between man, society and nations as altered by technology through time.

It could clarify the relationships between men and their livelihoods as moulded and remoulded by technology.

Concepts of family and community as they have felt the impact of technology could be covered.

Trends could be reviewed in materials, energy conversion, and mechanism.

Finally the social and commercial implications of today's technological frontiers could be explored.

With such insight, non-technical management could better evaluate the data placed on its desk every day. Our corporate and government policy makers could better pick and choose the alternatives open to them. They could more easily decide what they should know before acting. They would be better able to use technology and data for more efficient and worthwhile programs.

Our technology demands as much of our non-technical people as the humanities demands of our technical people. And while technical people have long been willing to expose themselves to the teachings of humanities, our non-technical decision-makers have not yet exposed themselves to the lessons of technology. It's about time they did, and it's time you and I said so out loud.

Technology is exploding. Population is exploding. These explosions force new dimensions in management development whether management knows it or not. The practitioners in technology, you and I, must make sure that management becomes aware of its new dimensions and action must follow.

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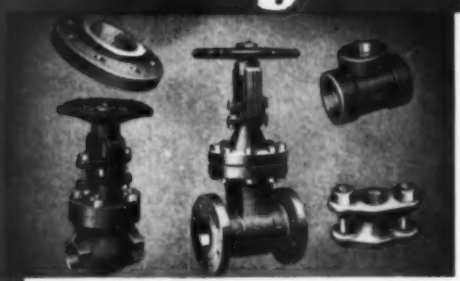

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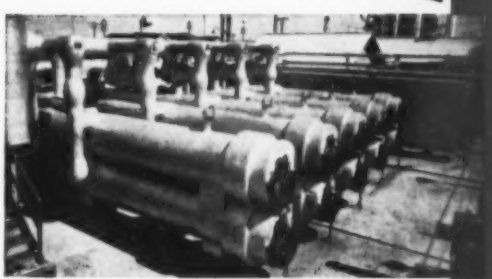

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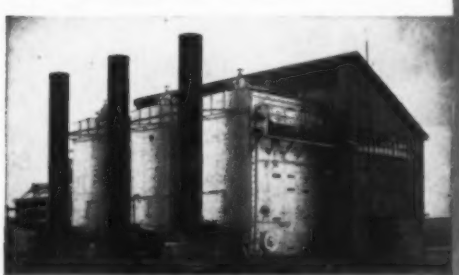

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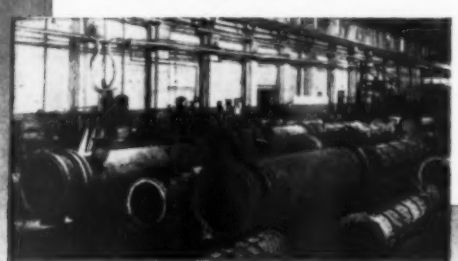

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GLOBAL STATISTICS

Quick Reference to World Oil Operations

MOST OF THE DATA used in the table are from the 12th annual World Round-Up of petroleum activities published in the June and July issues. The figures here are in more concise form so that information can be seen instantly.

In some cases estimates were made, based on information but not exact reports. Communist figures are based on some pretty vague material in most cases.

Rigs operating are rotary or turbo-drill. Cable tools in use but not included account for large number of wells drilled per rig. Consumption in many small areas is not listed, and ocean bunker demand (about 1½ to 1⅔ million bbl a day) is given in only a few cases so total consumption ran slightly over 19 million bbl daily in 1958. We consider refining runs data accurate except for some Communist countries.

We hope to continue this table at intervals to bring it up-to-date. We'd be pleased to have your suggestions about how it can serve you better. — *Ernestine Adams*

WORLD-WIDE PETROLEUM OPERATIONS IN 1958

Geographic area	No. rigs operating	Wells drilled in 1958	Production		Refining			Domestic consumption, products, b/d
			Crude avg. b/d	Gas avg. mcf/d	No. plants	Crude cap. b/d	Runs avg. b/d	
North America								
Alaska	7	6	—	—	—	—	—	15,000
Canada	194	2,516	453,514	1,099M	45	851,750	658,738	736,568
Hawaii	—	—	—	—	1	3,000	2,800	38,600
United States	1898	48,000	6,709,000	3,147M[2]	298	9,955,000	7,606,000	9,066,900
TOTAL North America	2099	50,522	7,162,514	3,148M[2]	344	10,809,750	8,267,538	9,857,068
Central America and West Indies								
Bahama Islands	1	—	—	—	—	—	—	1,500
Barbados	1	1	—	—	—	—	—	800
Costa Rica	1	2	—	—	—	—	—	3,150
Cuba	10	58	941	—	6	88,400	73,117	64,500
Dominica	2	1	—	—	—	—	—	6,500
French Islands[3]	3	—	—	—	—	—	—	4,323
Guatemala	3	1	—	—	—	—	—	7,000
Haiti	1	0	—	—	—	—	—	1,000
Honduras	2	2	—	—	—	—	—	50,000
Honduras (Br.)	2	5	—	—	—	—	—	400
Mexico	100	379	275,000	400,000M	8	357,000	297,000	280,000
Netherlands Antilles	—	—	—	—	2	650,000	645,000	2,500
Nicaragua	1	1	—	—	—	—	—	3,200
Panama	2	—	—	—	—	—	—	29,500
Puerto Rico	—	—	—	—	2	75,500	63,000	36,900
TOTAL C. A. & W. I.	129	450	275,941	400,000M	18	1,170,900	1,078,117	491,273
South America								
Argentina	100	345	98,380	105,000	15	217,600	215,000	250,000
Bolivia	17	—	8,300	—	4	12,500	5,500	5,500
Brazil	53	139	51,843	29,071	8	161,000	135,098	215,602
Chile	5	74	17,000	—	2	20,700	20,000	38,000
Colombia	46	167	128,000	—	5	73,900	64,500	48,000
Ecuador	3	—	8,925	—	2	6,300	6,410	10,000
Paraguay	2	2	—	—	—	—	—	1,600
Peru	15	—	51,320	112,000	3	46,800	44,215	41,600
Trinidad	32	295	102,343	200,000	3	186,000	165,000	38,000
Uruguay	1	6	—	—	—	—	—	24,655
Venezuela	108	1,150	2,604,840	1,100M[2]	16	780,000	690,000	143,000
TOTAL South America	382	2,178	3,070,951	1,101M[2]	58	1,504,800	1,345,723	815,957
Western Europe								
Austria	17	95	54,310	79	9	46,240	38,199	42,667
Belgium	—	—	—	—	8	175,000	130,000	112,000
Denmark	1	2	—	—	2	4,250	3,541	85,000
Finland	—	—	—	—	1	23,250	17,625	32,548
France	53	180	27,740	102,546	14	713,200	550,000	396,180
Germany (West)	103	534	86,000	33,000M	27	570,000	310,000	365,000
Greece	1	1	—	—	1	36,000	35,000	36,000
Italy, (Sicily)	31	90	32,320[1]	463,000	35	693,000	617,000	269,500
Malta	1	0	—	—	—	—	—	3,439
Netherlands	4	58	32,000	—	2	349,000	330,000	247,000
Norway	—	—	—	—	1	2,500	1,600	61,300
Portugal	1	1	—	—	1	26,000	22,400	22,000
Spain	8	11	—	—	2	150,000	130,000	120,000
Sweden	—	—	—	—	5	52,000	43,000	176,000
Switzerland	1	1	—	—	—	—	—	60,000
United Kingdom	6	27	1,575	68	16	778,400	524,000	640,000
Yugoslavia	16	45	8,300	96	3	24,500	22,100	21,000
TOTAL Western Europe	243	1,045	242,245	98,500M	128	3,643,340	2,774,465	2,689,634

[1]Sicily accounts for 30,420 b/d production.
[2]20 cable rigs.
[3]Martinique, Guadeloupe, etc., in West Indies; also other islands, New Caledonia, etc.

WORLD-WIDE PETROLEUM OPERATIONS IN 1958 — Continued

Geographic area	No. rigs operating	Wells drilled in 1958	Production		Refining			Domestic consumption, products, b/d
			Crude avg. b/d	Gas avg. mcf/d	No. plants	Crude cap. b/d	Runs avg. b/d	
Africa								
Algeria	38	140	8,700	1,000	—	—	—	19,650
Angola	5	12	2,000	—	1	2,000	2,000	3,060
Belgian Congo	1	1	—	—	—	—	—	10,000
Cameroons	1	1	—	—	—	—	—	1,800
Egypt	8	29	60,000	—	3	90,000	76,000	85,000
Fr. Equatorial Africa (Gabon)	18	22	9,000	—	—	—	—	3,000
Fr. West Africa	2	0	—	—	—	—	—	50,000
Ghana	1	5	—	—	—	—	—	7,500
Kenya	1	3	—	—	—	—	—	12,950
Libya	9	25	—	—	—	—	—	3,000
Madagascar	2	5	—	—	—	—	—	2,500
Morocco	4	14	1,559	180,000	1	3,250	3,157	20,000
Mozambique	1	1	—	—	—	—	—	500
Nigeria	8	14	5,164	—	—	—	—	11,000
Portuguese Guinea	1	1	—	—	—	—	—	100
Senegal	3	3	—	—	—	—	—	11,075[1]
Somaliland (Br.)	2	1	—	—	—	—	—	300
Somaliland (It.)	1	1	—	—	—	—	—	300
Sudan	—	—	—	—	—	—	—	8,000
Tanganyika	2	5	—	—	—	—	—	4,250
Tunisia	3	5	—	595	—	—	—	8,500
Union of S. Africa	—	—	—	—	1	24,300	22,300	79,200
Zanzibar	1	1	—	—	—	—	—	300
TOTAL Africa	112	289	86,423	180,595	6	119,550	103,457	341,985
Middle East								
Aden	—	—	—	—	1	120,000	78,000	2,000
Afghanistan	1	2	—	—	—	—	—	1,000
Bahrain Island	2	17	40,720	—	1	186,500	192,000	15,000
Iran	9	13	821,000	—	1	412,000	310,000	55,000
Iraq	10	15	698,650	—	4	55,830	42,000	30,000
Israel	5	12	2,500	—	1	85,000	26,000	36,710
Jordan	1	0	—	—	—	—	—	3,000
Kuwait	8	14	1,395,569	—	1	190,000	119,880	40,000
Kuwait (Neut. Zone)	2	49	80,300	—	1	50,000	35,000	2,500
Muscat-Oman (Dhofar)	3	10	—	—	—	—	—	100
Lebanon	—	—	—	—	—	23,000	18,000	20,000
Pakistan	3	5	4,900	36,878	—	—	—	39,000
Qatar	2	4	176,000	—	1	600	600	2,000
Saudi Arabia	5	8	1,015,029	—	—	189,000	168,119	8,000
Syria	3	5	—	—	—	—	—	16,000
Trucial Coast	2	4	—	—	—	—	—	500
Turkey	12	23	7,000	—	1	6,250	5,500	31,665
Yemen	—	—	—	—	—	—	—	300
TOTAL Middle East	68	181	4,241,668	36,878	12	1,318,180	995,099	302,775
Far East & Oceania								
Australia	11	32	—	—	7	211,200	196,000	195,266
Borneo (Br.)	7	18	102,000	—	1	50,000	46,000	3,500
Burma	5	23	8,200	—	2	8,500	7,800	7,200
Ceylon	—	—	—	—	—	—	—	20,000
China (Formosa)	6	8	41	40	1	24,700	16,725	14,000
India	6	7	8,500	—	4	104,500	100,000	115,000
Indonesia	16	52	336,000	76,000	5	247,800	232,600	78,200
Japan	80	751	7,021	35,579	23	552,900	277,400	280,295
Korea (South)	—	—	—	—	—	—	—	11,000
New Guinea (Neth.)	2	5	5,670	—	—	—	—	1,000
New Zealand	2	2	43	—	1	80	33	37,000
Pakistan	7	11	6,200	36,878	1	7,500	6,800	39,000
Papua & Br. New Guinea	2	4	—	—	—	—	—	3,000
Philippines	2	4	—	—	1	25,000	24,083	44,088
Thailand (Siam)	2	10	—	—	—	—	—	5,000
Timor	1	0	—	—	—	—	—	800
TOTAL Far East & Oceania	149	927	473,675	148,497	46	1,232,180	907,441	854,349
TOTALS Free World	3,182	55,549	15,553,117	4,747M[2]	610	19,798,700	15,471,840	15,353,041
USSR & Satellites								
USSR	850	—	2,260,000	2,900M	78	2,400,000	2,300,000	2,100,000
China (Red)	45	—	18,000	—	7	42,000	40,000	80,000
Romania	54	—	230,000	491,000	15	220,000	170,000	110,000
Hungary	30	—	15,000	—	5	37,000	35,000	39,000
Albania	16	—	8,000	—	2	6,000	6,000	5,000
Poland	10	—	4,000	—	5	15,000	12,000	36,000
Bulgaria	3	—	5,700	—	1	2,000	1,500	14,000
Czechoslovakia	3	—	2,800	—	4	26,000	20,000	22,000
Germany (East)	3	—	600	—	5	35,000	30,000	45,000
Korea (North)	2	—	—	—	1	5,000	3,000	10,000
TOTAL USSR & Satellites	1,016	9,000	2,544,100	—	123	2,788,000	2,617,500	2,461,000
WORLD TOTALS	4,198	64,549	18,097,517	—	733	22,586,700	18,089,340	17,814,041

[1]This includes consumption in Mauritania, etc.

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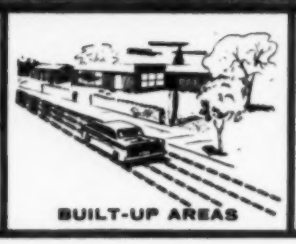
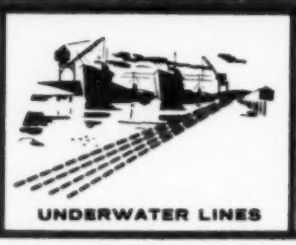

BUILT-UP AREAS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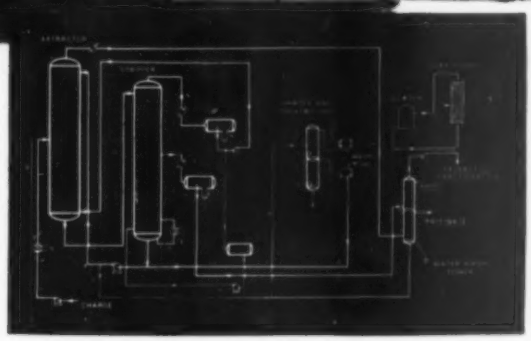

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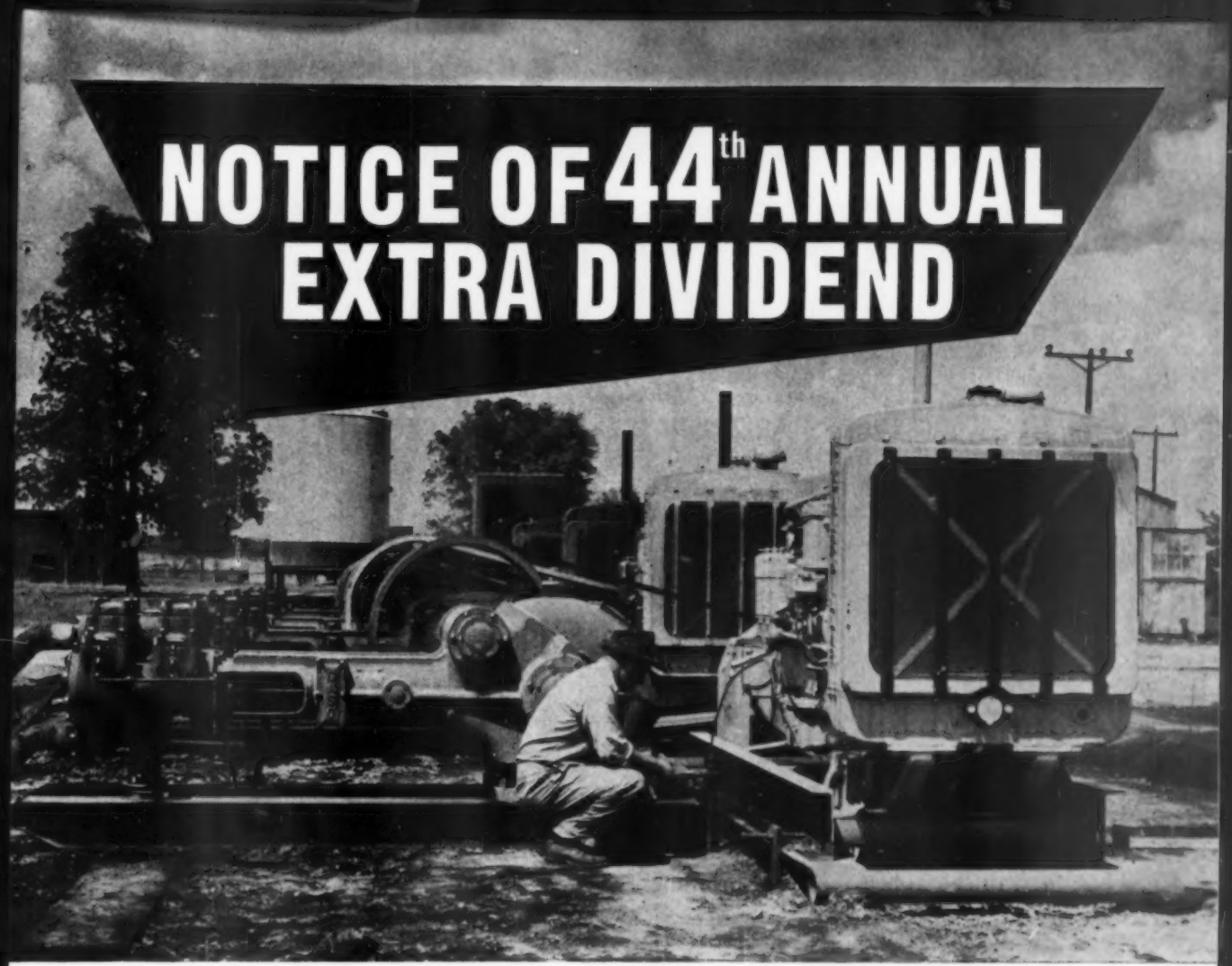

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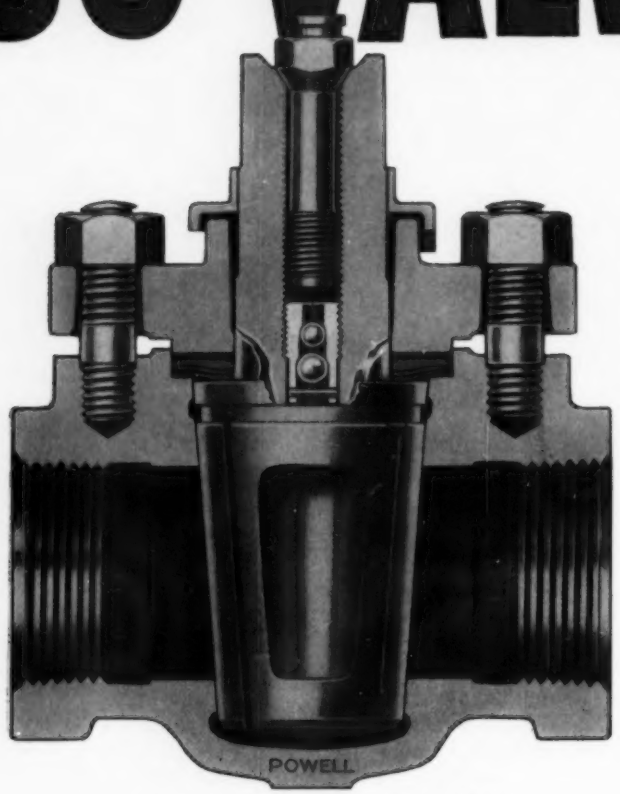

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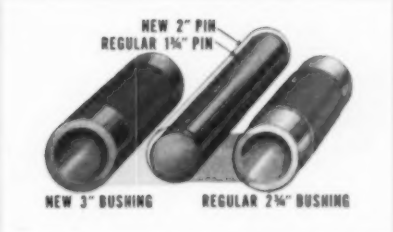
Caterpillar's continuous research and testing pay off for you with the development of superior D8 track components. The next time you replace track parts, specify these new components. They last longer and require less maintenance. Here's what's available for 2U, 13A, 14A and 15A tractors:

30% STRONGER PINS AND BUSHINGS have more wear area to extend life. The big track pins are ¼" larger in diameter and heat-treated deep to resist wear . . . pins will not bend and cause uneven wear. The large contact areas of the bushings are hardened deep, both inside and out. Under field conditions these bushings have lasted up to 44% longer than regular bushings.



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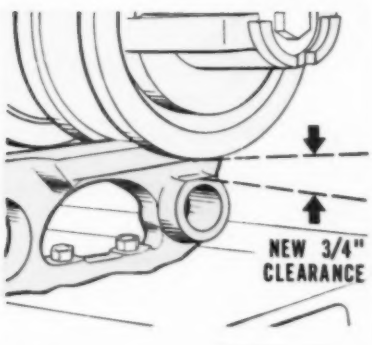

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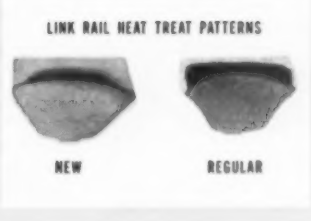

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HOW TO BE A MANAGER

Why Do People Act That Way?

Robert W. Dorman

"Even to be moderately successful we must learn what motivates people and what to do about it."

IT WOULD CERTAINLY be interesting if we always knew *for sure* what is in the other man's mind, and what his purposes and desires are. Think how much easier a manager's job would be if he had a really clear understanding of exactly what "motivated" each of his men at any instant! We know that the skill in understanding people is a particularly valuable one for a manager.

Here's what Mr. A. L. Nickerson, President of Socony Mobil Oil Company, Inc., says:

"We know that when we are looking for men with executive ability to promote, their technical knowledge at that stage is often relatively less important than their ability to deal wih more abstract problems involving judgment and ability to reason. There is, in fact, a sort of crossing of lines in this regard. While a man's technical knowledge may be his best tool during his first five years or so with our company, in many cases this curve tends to flatten out on the value chart and is met by the ascendant curve of the man's skill in human relations and other factors."

Let's ask ourselves some questions: Why will an old-time "expert" resist change? Why will a new trainee want to take shortcuts in his work? Why don't two employees get along well together? Why does the boss always want to know what it costs? Why does a customer hate a previous supplier? Why does an employee resent the idea of changing vacation dates? Why may a field manager be irritated by Home Office directives? Why is an employee bad-tempered one day, happy the next?

Robert W. Dorman *is Coordinator of Executive Development for General Petroleum Corporation, the West Coast member of the Socony Mobil Oil Company family. Mr. Dorman received his bachelor's degree in physical chemistry from Dalhousie University in Halifax, Nova Scotia, and his MSc in organic chemistry from McGill University in Montreal, Canada. After a few years of teaching chemistry, physics and mathematics, and after five years in the Canadian Navy where he became a Lt. Commander, Mr. Dorman was then an editor for McGraw-Hill Publishing Company in New York, and a contributor to scientific journals.*

With General Petroleum much of his time has been spent in the training of salesmen and supervisors, and he has taken some of this training to other parts of the world.

Why do they act that way?

Most of us learn, eventually, quite a bit about the answers to these questions. We *must* learn the answers to a lot of questions like these, if we are to be even moderately successful. We learn to recognize at least in general terms what motivates people.

Recently one of our managers conducted a series of interviews with 73 young field men, in connection with promotional changes, and brought to light their conviction that "most important ability" of a manager was to understand and "get along with" people. As *managers* we must get work done through people, which means that we must know how to get their willing cooperation. But much of what we know we have learned by trial and error, and, at the pace of modern business — this is a pretty expensive way to learn.

There are plenty of good books and study courses containing technical information on what makes people behave like people. To most of us this would be a fascinating study, if we had time to get into it. But apparently not very much of it can be taught in the early years — it must come mostly as a result of personal experience.

Is there any general guidance from all the information that is available? Are there any simple truths about all people? Is there any basic principle we can remember and use? What are the clues that might be useful to a young man as he faces a career of dealing with people every day?

If we asked the people mentioned above *why* they did these certain things — *why* they took these actions — their answers would certainly vary, but there would also be a pattern to those answers. The answers they would give you regarding their behavior would be like these:

"It takes too much time."
"I wanted to."
"He insulted me."
"My boss told me to."
"I'll make more money this way."
"It is the right thing to do."
"It will help me in my work."
"I get a sense of satisfaction from it."

A BASIC PRINCIPLE

There is a rather simple statement that brings together all these answers and expresses the basic motivation of all people. It goes something like this: People always act in such a way as to improve or defend what they have or hope to have.

They act to improve or defend what they have or hope to have.

Perhaps the best check on this statement of motivation is to look within ourselves, ask ourselves the reasons for our own behavior. No matter whether its in large affairs or in the small affairs, we act in accordance with this statement.

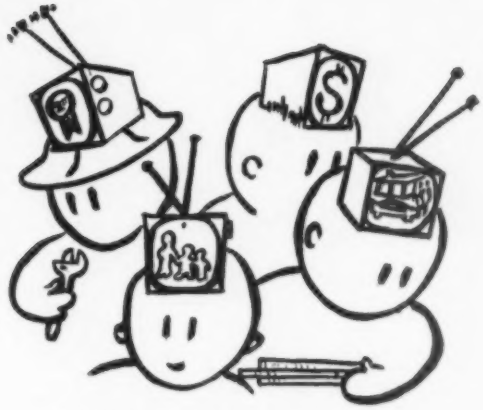
It might be interesting at this point to list, for yourself, the real reasons why — (for example) — you go to work every day — or why you live in the area you do — etc.

So — people act in such a way as to improve or protect what they have — that is, to protect the prestige they have, the material progress they are making, their sense of importance, the security they have, the pleasures they enjoy, their self-respect, the admiration of others, their health — and so on.

This is the **basic motivation,** regardless of the nationality of people, or their education, or any of the other factors that make people "different."

People are different because the things that they try to improve or defend are different. (Who was it said: "No two people are alike, and they're both glad of it?")

One man places money at the top of *his* list and is driven by the urge for that. Another individual desires a sense of accomplishment more than most other things. Another person wants pleasure more than anything else. Another man values peace of mind. Another desires excitement and challenge above all else. Everyone wants *some of each* of these things — but the difference in people is the different values they place on them.



People are different because the things they value are different.

So, each individual establishes his own pattern of motives . . . and the pattern changes over the years. A trainee in the company wants (let's say) challenge . . . 25 years later he wants (let's say) security.

This idea, that individuals act to hold or increase what they have, certainly is not a new notion. It is the basis of most sales courses, and of many courses in supervision.

And we all know of course that the "gains" of any individual do not need to be just for himself. Motives of an individual usually include the building or the preserving of good things for many other people — his family, friends, the company. Indeed, when we "like" people, we act to bring them benefits that are on *their* list, and not necessarily on our own.

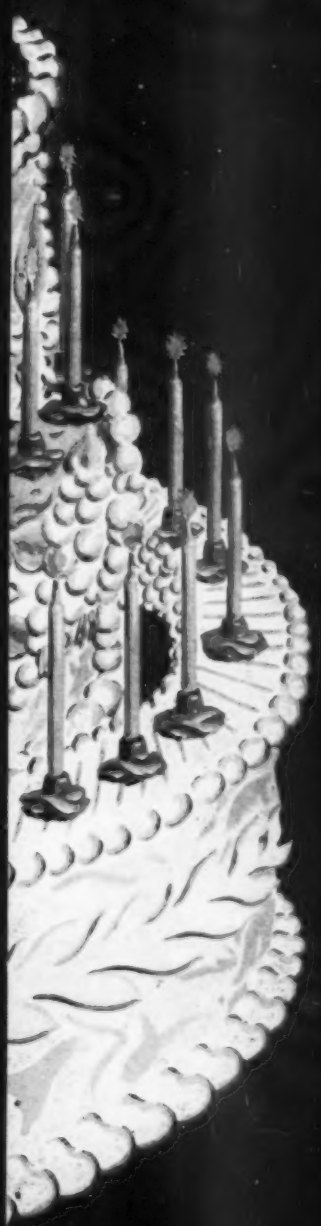
If we can keep in mind that people act *so that they will be better off afterward,* we have got hold of a basic truth. It is perhaps obvious, but as Oliver Wendell Holmes said, we need "education in the obvious." We recognize it clearly for our own case — but the very principle itself makes it difficult to recognize that it applies to others!

WHAT TO DO ABOUT IT

The self-education begins with recognizing that we must try to act in accordance with the other man's viewpoint (as shown by what he values on his list of "wants") if we are to gain his personal regard and his help. We must train ourselves (and it's not easy) to look at things as he would look at them — try to identify the kind of personal objectives he has — and see if our proposals can contribute to

Keep in mind what the other fellow wants.

1859
1866
1956
1957
1958
1959



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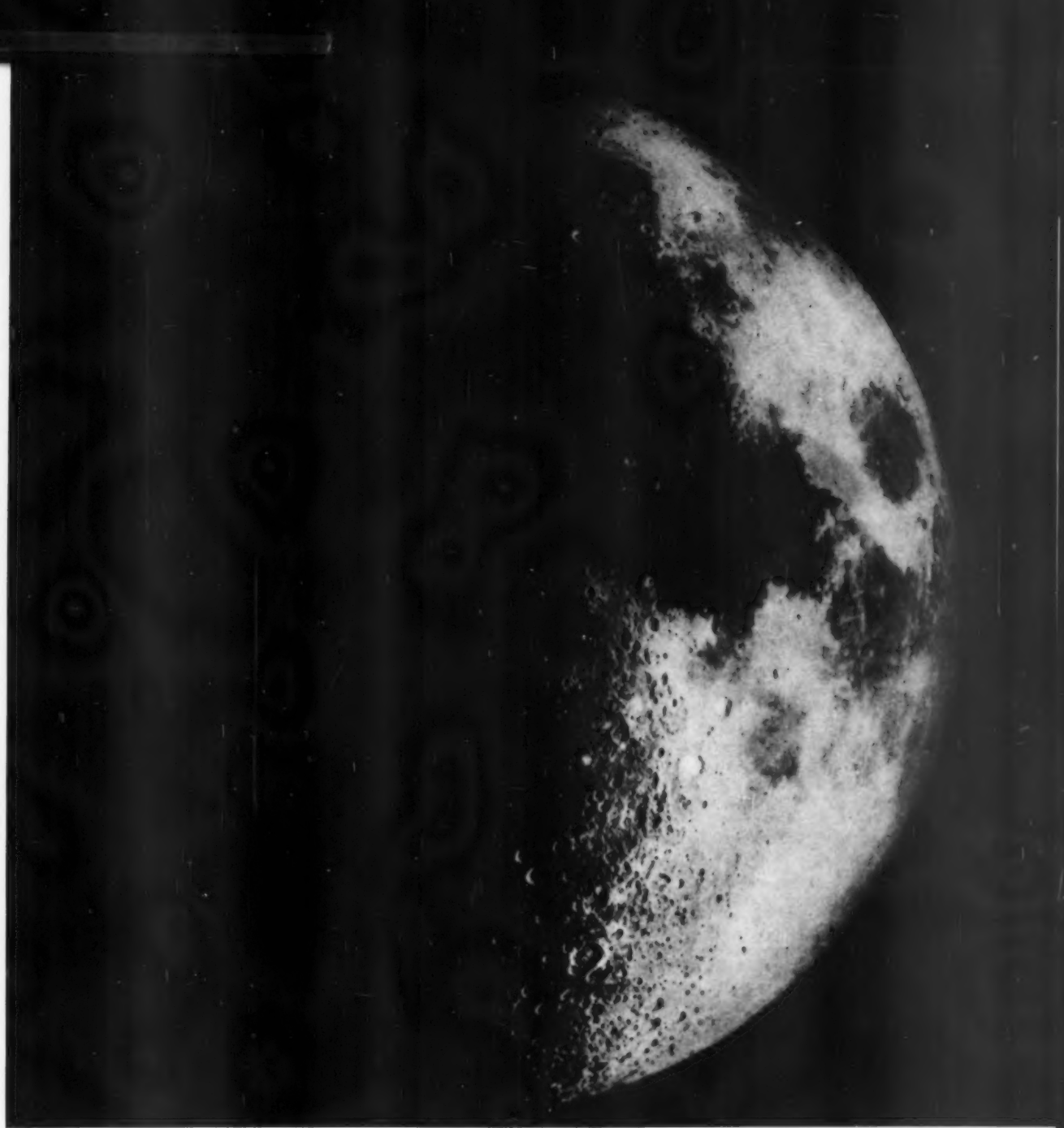
THE 69½ FEET THAT REACH THE MOON



From a hole no deeper than that, drilled in Pennsylvania 100 years ago, have come endless miracles of oil.

Today, petroleum gives us fuels that are capable of moving man from earth to the moon and beyond. Such explorations can bring new knowledge of incalculable value.

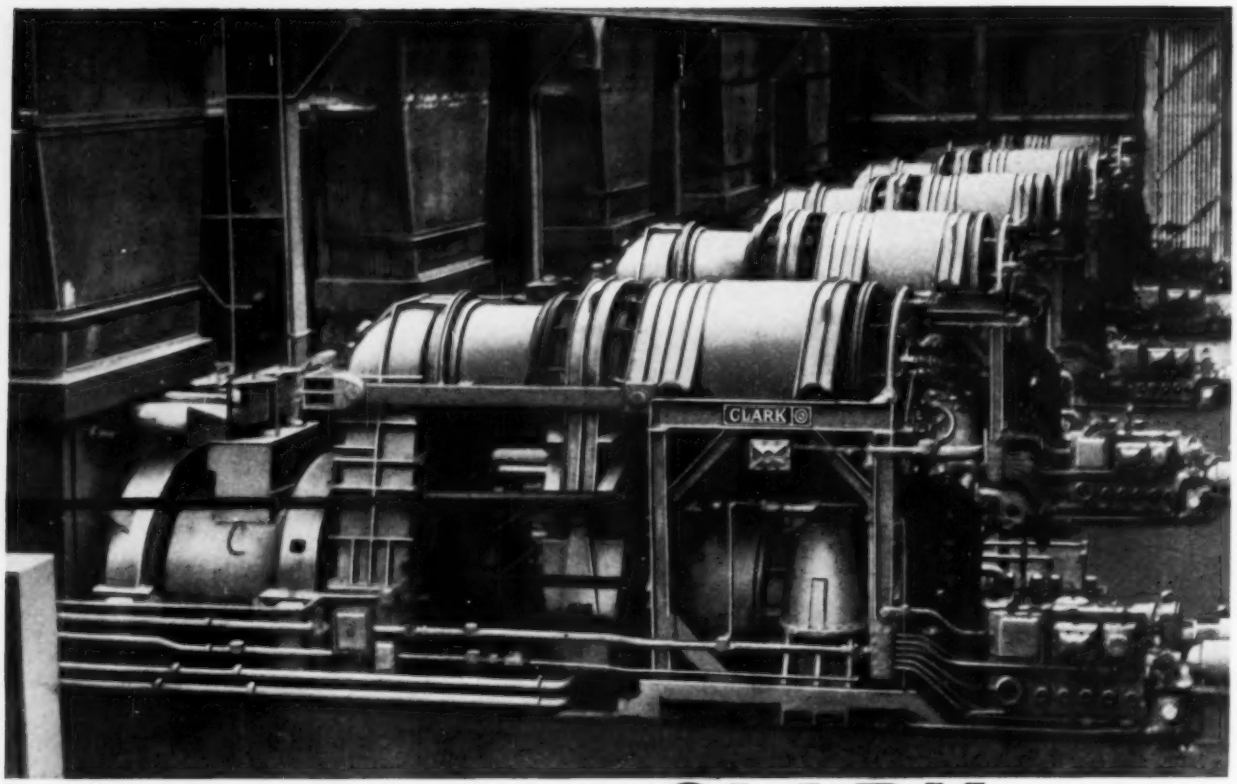
But no less certain than that we will one day fly through space is that we will have ever better fuels and lubricants for travel on the ground, on the sea and in the air – new and exciting products for the farm, industry and the home.

Today one quarter of all the money spent by U.S. industry on research is spent by the petroleum industry.

And as chemists study the endless ways to re-arrange oil molecules to make useful products, we can see that the age of petroleum has only begun.

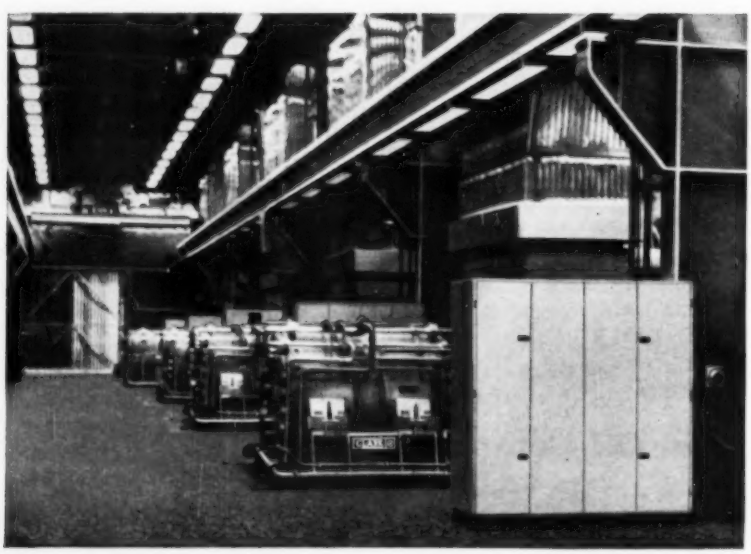
Standard Oil Company (New Jersey) esso

OIL'S FIRST CENTURY
BORN IN FREEDOM
WORKING FOR PROGRESS



Five Clark Model 305 Gas Turbines drive Clark vertically-split centrifugal compressors operating in series. The station is highly automated with only two operators required per shift.

CLARK Gas 210,000,000



In the Arabian Desert...

At 'Ain Dar, Saudi Arabia, five Clark Model 305 Gas Turbines are driving Clark Vertically-Split Centrifugal Compressors for the gas injection program of the Arabian American Oil Company.

Surrounded on all sides by the torrid Arabian desert, the turbines and compressors are installed in a pressurized building to keep out wind driven sand. Available fuel for the turbines is sour gas while ambient temperatures soar to unusually high levels.

The 'Ain Dar injection plant draws gas from five gas-oil separator plants at a pressure of 125 psig, compressing it to 2100 psig for injection. Any four of the five series connected, turbine-driven Clark compressors can provide the necessary pressure ratio for injection. Maximum flexibility is achieved by the use of dual shaft gas turbines. An additional Model 302 turbine drives a 5600 KW generator to power the gas-oil separator plants.

Turbines Power Aramco SCFD Gas Injection Plant

Proved dependability, minimum maintenance and the low installation costs experienced by other users of Clark gas turbines were important factors in selecting the turbines and compressors for the 'Ain Dar plant.

The fact that some of the Clark turbines and compressors could be delivered from the Olean plant and the balance from Italy, was also of prime importance to Aramco.

Clark 305 and 302 gas turbines have a standard rating of 8700-9300 bhp. 1220 bhp. models are also available. Consult your Clark representative for your next gas turbine or centrifugal compressor project or write for descriptive literature.

CLARK

CLARK BROS. CO.
OLEAN, N. Y.
One of the Dresser Industries

COMPRESSORS • GAS TURBINES

these things. Indeed, one measure of wisdom, of good judgment, of maturity is in the extent to which we are able to appreciate the other man's viewpoint, and to realize that our own true self-interest is best served by bringing something to other people.

To quote Mr. Nickerson again: *"The job of management is in the most fundamental sense the job of developing people."*

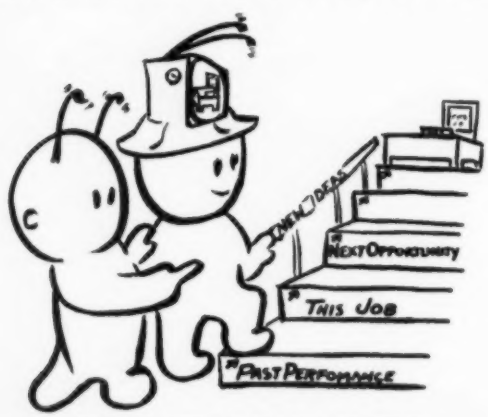
It may sound idealistic to say that we gain most by helping others, but if we check *our* reactions to other people and *their* ideas, we will see that this is the only sure way to build our relationships with others. One manager becomes simply "an enforcer of rules" because he will not consider the viewpoints (the personal needs — the motivation) of the employees involved. Another manager, thinking along the lines of what motivates his men, gains a reputation for getting the job done *right* while building and holding their liking and respect.

It is generally recognized that the oil industry is "a good one" from the standpoint of its concern for its people, and for a recognition of the fact that training in the skills of management is vitally important. Over the past 10 years, for example, Socony Mobil has provided training in the supervisory skills for something like 4000 of its managers and potential managers. And this course of study — which was taught not by a few specialists but by about 120 management men themselves — is based on the principle we are examining: that people "act to benefit."

This particular study was carried to Europe, the Near East, Central and South America, and Australia, and of course (because it considers the similarities of people rather than their differences) it works just as well in those spots as in America.

If we can accept the idea that "people act that way" because they believe it is the most favorable way to act from their point of view, then we have some guidance for *presenting* ideas to individuals. When we are going to talk to someone for a special purpose (we always have *some* purpose, of course — but let's think of a manager making a suggestion to an employee) the key idea we should present to an individual should be a constructive one — a useful one — from his point of view. And while he thinks of his objectives in large terms like "more income," "feel better," etc., he must attain these things in definite ways, by definite actions, and so our proposals should clearly explain those ways.

If we do this, if we carefully attempt to determine the key motivation for this person, at this time, on this subject (i.e., the key things he wants), then our manner of speaking and the words we select to present our ideas, are more likely to be right. If the subject is a delicate one, we'll be recognizing the other person's viewpoint if we approach the subject indirectly, cautiously; if a man is hesitant and fearful by nature, we'll often be helping him most by being direct and positive in our proposals, — and so on.



Present the suggestion in terms that appeal to *him*.

OUR NEGATIVE BEHAVIOR

When anyone resists an idea he is acting in accordance with our basic statement of motivation. In other words a man reacts negatively when he believes that his interests

The negative is only the other side of his point of view.

are *not* being considered or are *not* being improved or protected by the proposal.

When a man raises an objection to our proposal, chances are that it is really our fault, because we did not talk from his point of view. For example: If we are too blunt in a suggestion, the listener voices resentment *not* because we are incorrect, but because we have hurt his pride. Also, from a reasoning point of view, we know that he will act only if he sees "good reason" to act. Yet in making the suggestion to him we probably did not make this good reason clear and so he set up a roadblock.

An "old-time expert" may resist change because the change may indicate that the way he has been doing things appears now not to be the best way. So — to protect his own prestige, to maintain his self-respect, it is natural for him to resist. Since it is natural, we can train ourselves to become patient and understanding of it.

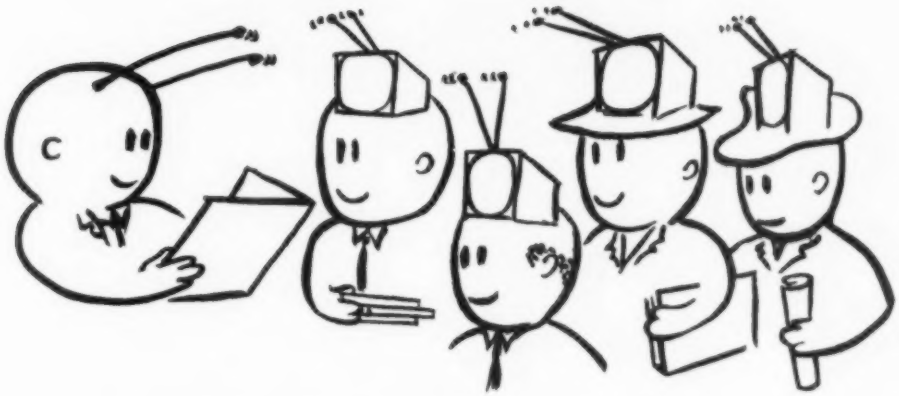
The solution lies in first reassuring him of the value of his work, and then in getting his help to identify (or consider) the good reasons from his point of view for the new procedure. As managers we *must* get the new procedure accepted — the critical skill is how we gain that acceptance.

A brand new trainee may want to take (unwise) shortcuts in his work because that seems to be the way he can bring the most rewards to himself — get it done fastest so he can move on to something more interesting — show his zeal and cleverness to his boss — etc. Again, this is understandable from his point of view.

The solution lies in making clear to him (if it is true!) that in the long run the more thorough and complete way is the better for him, *his* career, *his* enjoyment, *his* progress . . .

Two employees do not get along with each other because they do not contribute to the things that each feels is important — so, there is loss of prestige, misunderstanding of motives, suspicion, resentment, poor cooperation on the job, etc.

A good manager will first recognize that this is a natural reaction, that the solution is either in clearing the air so that the two *do* understand each other, or in arranging office, work, or organization changes that will keep them separate.



The manager must be tuned in to his people's motivations.

And, incidentally, the manager himself takes action on this situation because, from *his* point of view, the department work must get done promptly and correctly.

A boss demands to know the cost of everything because he is held responsible for the finances of his department. His progress and peace of mind, his sense of satisfaction, his pleasure in the job, certainly depend in some measure on his use of company money. Thus, it is "natural" for him to want figures.

A customer may hate a previous supplier because of some personal affront that harmed the man's sense of personal worth (perhaps his most valuable possession!) — or because the supplier may have brought him some material losses which indicated lack of reliability. In short, the supplier did not act from the viewpoint of his customer.

And, if the supplier is ever to regain the business, he will have to go back and repair the damage — and *then* keep in mind why the customer "acts that way."

An employee resents the idea of changing vacation plans because of the inconvenience to him and he may feel that his needs were not considered adequately. This makes sense from his point of view. The solution lies first in recognizing his viewpoint and then identifying the good reasons from *various* points of view for the necessary decision.

Field personnel may resist suggestions from the headquarter's office because they do not see that these things are in their (the field's) best interests. The letter or presentation should clearly identify the strength of the proposal from the field's point of view.

If a fellow worker is moody, the real reasons are sometimes beyond our right to determine, or our ability to correct. Whatever the reasons are, they must "make sense" from his point of view. Therefore, we can at least be helpful in our personal attitude.

The solution is in helping him if we can to recognize the good reasons, from his viewpoint, for overcoming moodiness on the job.

The pattern in all these examples is visible. In each case the individual acts in such a way as to improve or defend what he believes is best for himself or others with whom he is concerned. This is the basic principle. This is "why people act as they do."

To improve our skill in dealing with people we must work in accordance with this principle. This we can do by first determining as accurately as possible what his interest is in this matter, then speak from that viewpoint.

Resistance is natural so we must be understanding of it, and handle it by helping the other individual to recognize the rightness of our proposal from his viewpoint. ★ ★ ★

Give Yourself a Quiz

Why, do you suppose, individuals act like this?

a. a man refuses a promotion . . .
b. a clerk would "rather work for this other supervisor" . . .
c. an individual works very hard, on his own time, with no pay, for a Service Club . . .
d. a Manager seldom delegates . . .
e. employees form a Club . . .
f. a man quits after 2 years . . . after 20 years . . .
g. a customer complains bitterly . . .
h. a car driver goes back to the same service station, year after year . . .

What would be some of the ideas you might use to solve these problems?

a. an employee is regularly late . . .
b. a worker seldom completes an assignment . . .
c. a supervisor never really *explains* anything . . .
d. an employee does not mix with his co-workers, eats lunch by himself, etc. . . .
e. a clerk is continually bringing in new (but silly) ideas . . .
f. two workers are always arguing about religion . . .
g. an ex-customer refuses to tell you why he stopped dealing with you . . .
h. an employee insists on telling you his home problems . . .

Read These, Too:

[1]*Argyris, C., Personality and Organization, Harper, New York, 1957.*

[2]*Bursk, E. C., ed., Human Relations for Management: The Newer Perspective, Harper, New York, 1956.*

[3]*Overstreet, H. A., The Mature Mind, Norton, New York, 1949.*

[4]*Von Mises, L., Human Action, Yale Univ. Press, New Haven, Conn., 1949.*

[5]*Whyte, W. H., The Organization Man, Doubleday, New York, (Anchor Book), 1956.*

[6]*Gardner, B. B. & Moore, D. G., Human Relations in Industry, Irwin, 1955, text. ed.*

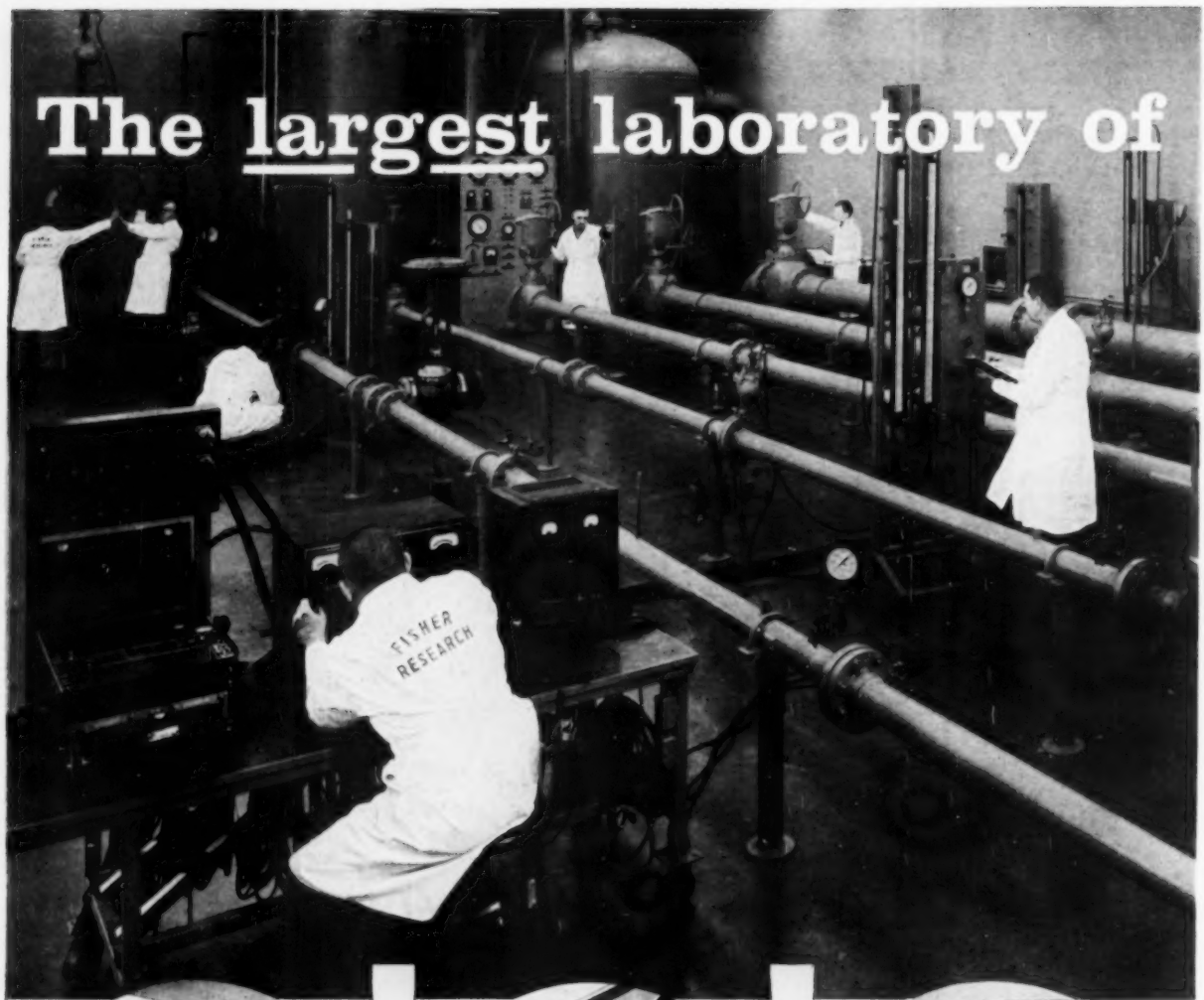
[7]*Laird & Laird, Sizing Up People, McGraw-Hill, New York, 1951.*

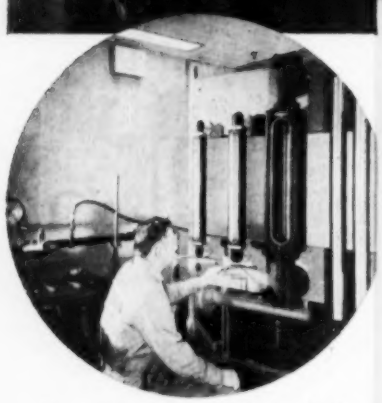
[8]*Ordway Tead, Human Nature and Management, McGraw-Hill, New York, 1933.*

[9]*Parker & Kleemeier, Human Relations in Supervision, McGraw-Hill, New York, 1951.*

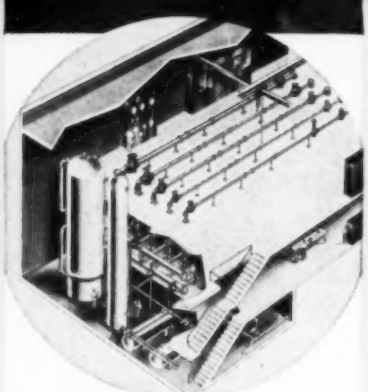
[10]*Carl Heyel, Human Relations: Manual for Executives, McGraw-Hill, New York, 1939.*

The largest laboratory of





Flowmeters and manometers are just two types of precision equipment used for accurate measurement in this unique laboratory.



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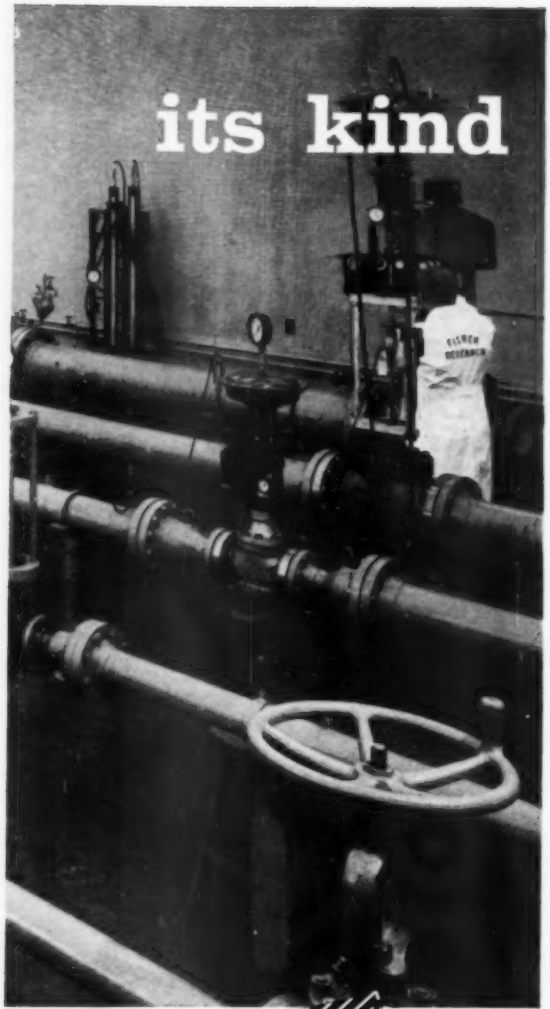
A Fisher engineer obtaining frequency response data of Fisher equipment under test on an oscillograph.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...



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- All flows are metered with orifice plates and differential manometers. Liquid flows can be metered up to 6000 GPM and gas flows up to 7,000,000 SCFH.
- Actual flow test curves are recorded on each Fisher valve design. This gives a visual record of the operating characteristics of each piece of Fisher equipment and proves that its performance in the line will precisely match published data.
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Management Personals

R. Girdler

▸ **Reynolds Girdler,** director of public relations and advertising, was elected a vice president of Sinclair Oil Corporation. He joined Sinclair in 1952, after many years in the fields of financial writing and advertising, including an editorship on *Time Magazine*, columnist for *Nation's Business*, and vice president of Distributors Group, Inc., mutual fund sponsors and managers.

▸ **Daniel M. Doherty** of Croton-on-Hudson, New York, was named press relations representative of the Committee on Public Affairs of the API. He succeeds **J. Richard Shaner** who resigned to join *Petroleum Week* in New York City. Shaner had been publicity manager for the past 10 years.

▸ Atlantic Refining Company has combined advertising and sales promotion departments with **J. H. Picou,** also director of marketing research as head. **Richard Borden** will manage the advertising division and **E. R. Cox Jr.,** the sales promotion division. Picou has been director of marketing research since 1956.

▸ **Chalmer G. Kirkbride,** executive director of the research and engineering department of the Sun Oil Company, and president of AviSun Corporation, was presented an honorary Doctor of Science degree for his achievement in the field of science and research by Beaver College in Pennsylvania.

▸ **W. F. Styler Jr.,** was appointed financial vice president of Crescent Petroleum Corporation. He was previously vice president and treasurer. **R. N. Tuggle** was named treasurer and **W. M. Leitner** controller.

▸ **Raymond K. Pearson,** division comptroller and services coordinator for Gulf Oil's production department at Houston, has been transferred to the general offices at Pittsburgh where he will be an assistant comptroller.

J. Frank Drake has resigned as an active member of Gulf's board of directors. In recognition of Drake's outstanding service to Gulf that began 40 years ago, the board designated him director emeritus, the first such title conferred by the company.

▸ **Bayard C. Low,** after 39 years in the petroleum industry, and most recently management assistant in Humble Oil & Refining Company's crude oil department, has retired.

▸ **J. A. Mawhinney Jr.,** manager of the training division in Shell Oil Company's head office employee communications department, was named manager of the wage and salary division of the head office organization and salary department. He succeeds **R. M. Lee,** who becomes staff manager in the new administrative services department in the head office exploration and production organization. **R. W. Hester,** assistant manager of the policy and benefits division in the head office personnel department, succeeds Mawhinney.

▸ **W. Alton Jones** was elected chairman of the executive committee and **Burl S. Watson** chairman of the board and chief executive officer succeeding Jones in those capacities of Cities Service Company. **J. Ed. Warren** was named president, succeeding Watson in that position. Three senior vice presidents elected are **A. P. Frame, Charles S. Mitchell** and **George H. Hill Jr. Erle G. Christian,** formerly secretary, and **Edward L. Stauffacher,**

W. Alton Jones

B. S. Watson

J. Ed. Warren

formerly president of the eastern region subsidiary, Cities Service Oil Company (Pennsylvania), were named vice presidents.

Robert L. Kidd is president of Cities Service Oil Company (Delaware).

▸ **Dr. Charles L. Thomas** was appointed Sun Oil Company's first scientific advisor. In his new post, Dr. Thomas will furnish scientific leadership in research and engineering and pursue his research specialties without administrative distractions. **Dr. Robert M. Kennedy** was named to succeed Dr. Thomas as director of research and development. Dr. Thomas, who now holds more than 100 patents, joined Sun in 1951 as a staff assistant in research and development. Dr. Kennedy came to the company as a research chemist in 1941. He holds about 40 patents relating to the development of new products.

▸ **J. W. Bartlett,** vice president, special projects division of Delhi-Taylor Corporation has retired. A veteran of more than 35 years in the petroleum industry, Bartlett joined Delhi in 1949 and was elected vice president of engineering in 1950.

▸ **Harold C. Morton,** Los Angeles attorney and oil producer, was elected to the board of trustees of the University of Southern California, his alma mater. Morton, senior member of the law firm of Hanna and Morton, is a recognized authority on oil and gas law and a partner in Harbor Refining Company.

▸ **Koos Scholtens** has retired from his posts as chairman of the boards and general managing director of The Iranian Oil Exploration and Producing Company and The Iranian Oil Refining Company. **E. W. Berlin,** deputy general managing director of the two companies, succeeds Scholtens.

▸ **Edward Symonds** was named to the petroleum department, The First National City Bank of New York, part of the bank's special industries group. Formerly with the International Bank for Reconstruction & Development (World Bank), he will direct the economic activities of the department.

▸ **Loren L. Ware,** vice president in charge of exploration, was elected a member of the board of directors of Sinclair Oil & Gas Company.

▸ **Robert Dunlop,** president of Sun Oil Company, addressed the graduating class after being awarded honorary doctor of laws degree at June commencement at Pennsylvania Military College, Chester, Pennsylvania.

▸ **William P. Schoentgen** was promoted to the new position of manager of employee communications in the public relations department of Standard Oil Company (Indiana). He has been an advanced writer in the public relations department, and was formerly editor of the monthly employee magazine, *Standard Torch*.
Byron Rice was appointed editor of the *Standard Torch*. **Bruce A. Cook** has become roving correspondent for the magazine. Rice has been editor of Standard's Whiting, Ind., *Refinery News*. Cook was formerly associate editor of *Heating, Piping and Air Conditioning* magazine.

▸ **K. H. Shaffer,** Houston oil executive, was named state chairman of the Oil Information Committee of the Texas Mid-Continent Oil & Gas Association. Formerly state vice-chairman of the OIC, Shaffer, who is president of Standard Oil Company of Texas, succeeds **G. T. Pearson,** Continental Oil Company, Fort Worth, who now heads up Conoco's Canadian operations.

▸ **Howard C. Pyle,** president of Monterey Oil Company and president of AIME, received an honorary doctor of engineering degree from the Colorado School of Mines. Pyle delivered the principal address during the commencement exercises.

▸ **Eugene T. Adair,** president of Fort Worth's Texas Pacific Coal and Oil Company, was named a member of the board of directors of Central Airlines.

DEATHS

▸ **Gilbert J. Weale,** 80, formerly treasurer of Buckeye Pipe Line Company and its subsidiaries, died June 12 at New Rochelle, New York, after a long illness.

▸ **H. E. (Ike) Lowrey,** vice president in charge of the export division for Continental-Emsco Company, died June 6, of a heart attack.

▸ **John M. Miner,** recently named vice president of Lane-Wells Company, one of the Dresser Industries, died in the crash of a Colombian Airlines plane in Peru June 24.

▸ **James F. Callery,** 63, publicity manager of the Lone Star Cement Corporation, died June 10.

▸ **Elmer R. Tieberman,** 58, retired sales executive of The Lunkenheimer Company, Cincinnati, Ohio, died June 24.

▸ **Jacob N. Fell,** 73, president of Bradford Company, Fell and Wolfe Oil Company, and Fell and Wolfe Investment Company, died July 5 after several months' illness.

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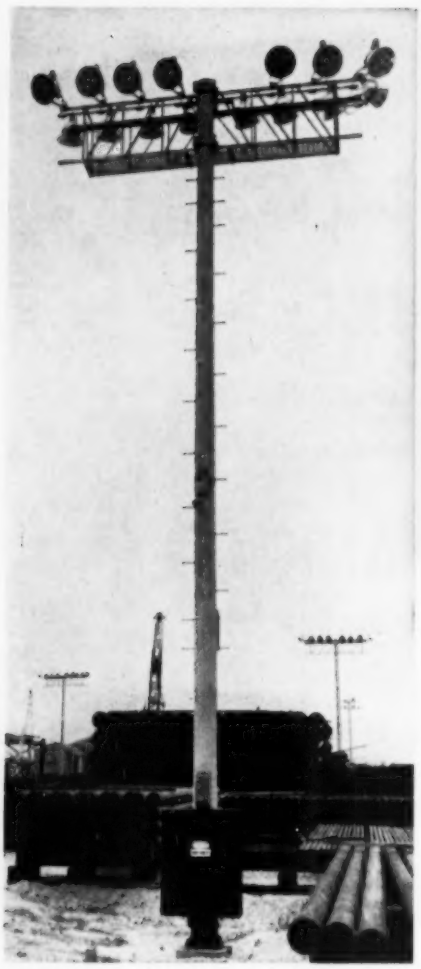
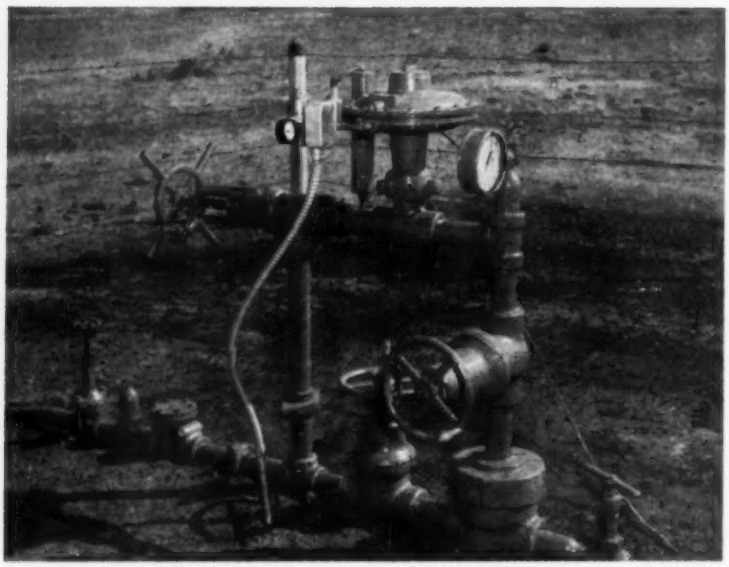
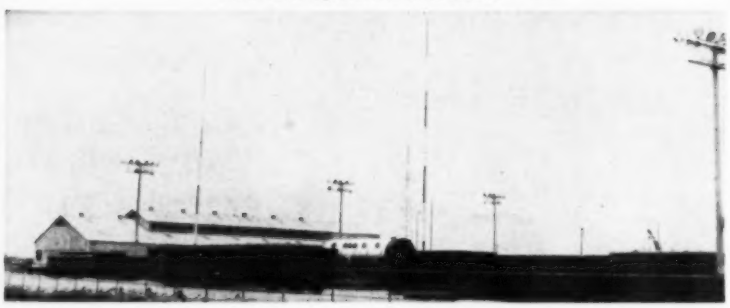




Electrically operated solenoid on flowing well with valve controlled by electric time-clock.



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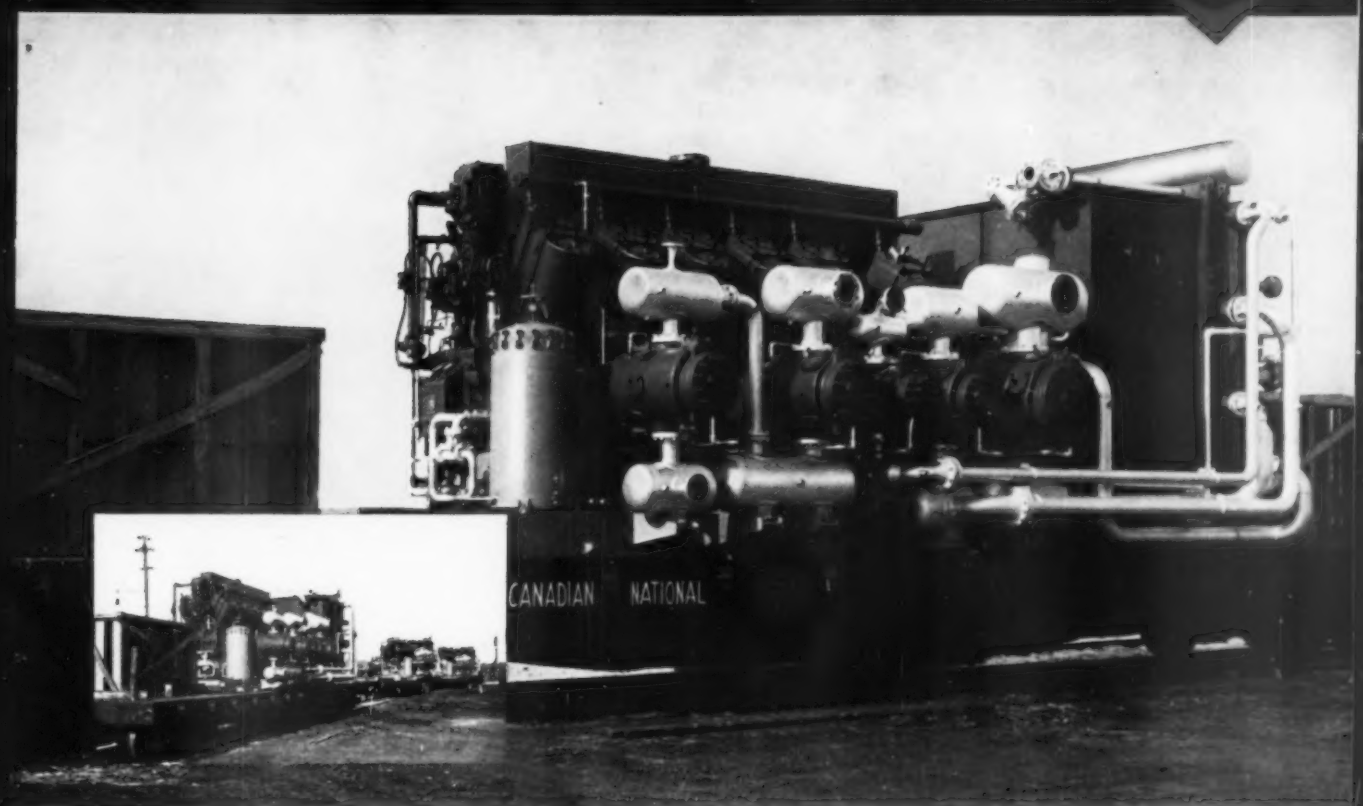

CANADIAN BUILT Beaird-Ingersoll-Rand, 660 h.p. 12SVG packaged compressor units have Young radiators with up-draft air discharge. Interstage gas, engine water and lubricating oil cooling sections are built into the radiator. Other sizes from 120 to 660 h.p.

Beaird Packaged Compressors—

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These three 660 h.p. Beaird-Ingersoll-Rand packaged compressor plants are among the first 18 Canadian-built units to be delivered by Beaird International, Inc., Calgary. This new Beaird subsidiary offers Canadian producers complete sales, service and available manufacturing facilities.

Designed for a major oil company, the units will serve a dual role in gas processing and boosting. Three stages will be used for gas boosting and two stages will handle propane for the chilling process. Another example of the flexibility possible in solving gas production problems, these compressors reflect Beaird's years of design and field experience.

With Canadian facilities, Beaird International offers a single source of responsibility from initial quotation to field service. Beaird offices in Caracas, Venezuela serve South American markets.

Wherever oil or gas is produced, there are skilled Beaird gas engineers to assist in finding an economical solution to your special operating requirements.

THE J. B. BEAIRD COMPANY, INC.
Shreveport, Louisiana
A Subsidiary of American Machine & Foundry Company

SALES OFFICES: *Shreveport, New Orleans, Louisiana • New York, New York • Tulsa, Oklahoma • Houston, Corpus Christi and Midland, Texas and Cie. Ingersoll-Rand, Paris, France.*

BEAIRD INTERNATIONAL, INC. SHREVEPORT, LOUISIANA • *Sales Offices: Calgary, Alberta, Canada • Caracas, Venezuela.*

It all started with a kerosine lamp

Today's commercial jets are powered by the same fuel that fed the parlor lamps and farm lanterns of only a few decades ago. In fact it was the search for this fuel — for *kerosine* — that gave birth to the oil industry 100 years ago.

In those days kerosine was a new source of abundant light that replaced the costly and limited supplies of whale oil for lamps. Today, electricity has displaced the oil lamp, but kerosine has again become the source of abundant and low-cost energy for the jet age. Without kerosine, and other petroleum jet fuels, jet flight would be extremely expensive and perhaps commercially impossible.

And so it has been for a century in nearly every area of industrial progress — petroleum has paced the way. From the gasoline that powers the modern car to the wash-and-wear suit made of petrochemicals, from diesel fuels and heating oils, farm fertilizers and asphalt for our life-line of highways, petroleum has made possible the way of life that is America.

TEXACO

CONSTANT PROGRESS IN OIL'S FIRST CENTURY

• News • People — The Trade PARADE

SCHOLARSHIP GRANTS. Hughes Tool Company has made awards in the form of scholarship grants to 8 seniors attending Southwestern colleges next September, according to Dr. Daniel J. Martin, vice president-engineering. Students selected for the Mechanical Engineering Award include Charles P. Cook of Cuero, Texas, and William M. McCandless of San Antonio, both attending the University of Texas; Theodore A. Dumas of Fort Worth, Texas Tech; M. U. Ayers Jr., of Madill, Oklahoma, Oklahoma State; Jerry E. Reynolds of Houston, Texas A & M; Dean Maynard Briggs of San Antonio, University of Houston; and Paul Leland King of El Paso, Rice Institute. Named to receive the award in Design and Drafting was Thomas J. Vanzant Jr., of Houston.

HAWAIIAN COMPANY FORMED. Formation of a company to manufacture polyethylene film and film products in Hawaii was announced by Pacific Chemical and Fertilizer Co., of Honolulu, and The Dow Chemical Company, of Midland, Michigan. The firm, to be known as Hawaiian Extruders, Inc., will be located in Honolulu. Its president will be R. Q. Smith, who also is president of Pacific Chemical and Fertilizer.

EXPORT REPRESENTATIVE. Baker Filtration Company of El Monte, California, has appointed Beckley-Haltom & Hickman Company of Rockefeller Center, New York City, as its export representative to handle the company's complete line of water filtration equipment.

APPOINTS CANADIAN DISTRIBUTOR. Canadian Well Services, Ltd. of Calgary was appointed Canadian distributor for Johnston hydraulic pumping units, manufactured by Engineered Oil Tools, Inc. of Houston.

Canadian Well Services has sales and service locations at Calgary, Olds, Red Deer, Stettler, Edmonton, Drayton Valley, White Court, Valley View, Estevan, Oxbow and Weyburn.

OPENS BEAUMONT FACILITY. Clark Bros. Co., one of the Dresser Industries, announced the opening of expanded facilities for packaging its line of field compressors. Located at the Beaumont, Texas, plant of Ideco, Inc., another Dresser Division, the new Clark operation is designed to permit rapid delivery of Clark Model CFA and CFB Packaged Field Compressors in Western and Southwestern United States. The units will be mounted on skids, equipped with all necessary piping, and tested prior to delivery at the oilfield site.

PIPE-COATING PLANT. Tube-Kote, Inc.'s new West Texas pipe-coating plant is in production. Built on a 17-acre plot on Tower Road near Midland, the $250,000 facility has a capacity of coating 8000 ft of pipe a day, and will employ between 30 and 35 men.

2 NEW FOREIGN COMPANIES. Formation of 2 foreign companies and an expanded program for a third were announced by Nalco Chemical Co.: Nalco de Mexico, S.A. de C.V., and Nalco International, C.A., which will handle certain Nalco commercial transactions in Venezuela and other South American countries. Nalco, Ltd., which was formed in January to handle sales in the United Kingdom, will step up its activities.

EXPANSION CREATES NEW POST. Robert E. Dunn was promoted to the post of assistant to the general manager of sales, announced by J. T. Tucker, general manager of sales for Cardwell Manufacturing Company, Wichita, Kansas. Dunn has been merchandising manager for the company since joining the firm in 1958. The newly-created post was added to further develop and expand the company's sales nationally.

R. E. Dunn

OPENS $600,000 PLANT. C-B Southern, Inc., has opened a new $600,000 plant in Houston to manufacture packaged gas compressors for world-wide distribution. The company is a subsidiary of The Cooper-Bessemer Corporation. Employing approximately 100 people, the new installation will have a capacity of 120 packaged compressors annually. The plant, built by the Triangle Construction Company, is located on a 28.3 acre tract, at 1400 Britmoore Road. With a 360-ft craneway, it covers 36,000 sq ft. Engineering and sales offices are located in a 5000 sq-ft building adjoining the plant.

1000TH GRADUATE. Ralph Bowers was presented a set of micrometer depth gages as the 1000 graduate of a Caterpillar Tractor Company service training school for dealer personnel. Bowers, a field serviceman for Nova Scotia Tractor and Equipment Co., Ltd. was one of five men attending the one week course at Caterpillar's plant at Peoria, Illinois.

DABCO SALES APPOINTMENT. Houdry Process Corporation announced the appointment of Lindeteves-Jacoberg, N.V., of The Hague, Netherlands, as a Houdry representative in Benelux (Belgium, Netherlands, Luxembourg), the United Kingdom and the Union of South Africa.

The Lindeteves-Jacoberg firm, one of Western Europe's largest trade organizations, will act as Houdry representative for DABCO, a new one-shot polyether catalyst used in producing urethane foams and elastomers.

3 DISTRIBUTION AGREEMENTS. Jones & Laughlin Supply Division now distributes flanges, welding fittings and other products manufactured by Taylor Forge and Pipe Works, Chicago.

Ohio Injector Company and J&L Supply announced a distribution agreement for OIC valves throughout the U. S. The announcement was made jointly by Roger E. Bremer, executive vice-president of Ohio Injector and Rainey Elliott, president of Jones & Laughlin.

An agreement to distribute Rockwell-Nordstrom Plug Valves through their stores and sales offices was also made. These valves are manufactured by Rockwell Manufacturing Company.

PERSONS-BEAUCHAMP ADVERTISING, INC. is the new name for The McCarty Company in Houston. Officers and personnel of the organization remain unchanged. Howard Persons is chairman of the board and Hal Jones is vice president. The agency maintains offices at 2472 Bolsover in Houston.

PRECISION MEASUREMENT AT ANY FLOW RATE

AMERICAN-WESTCOTT

A-88

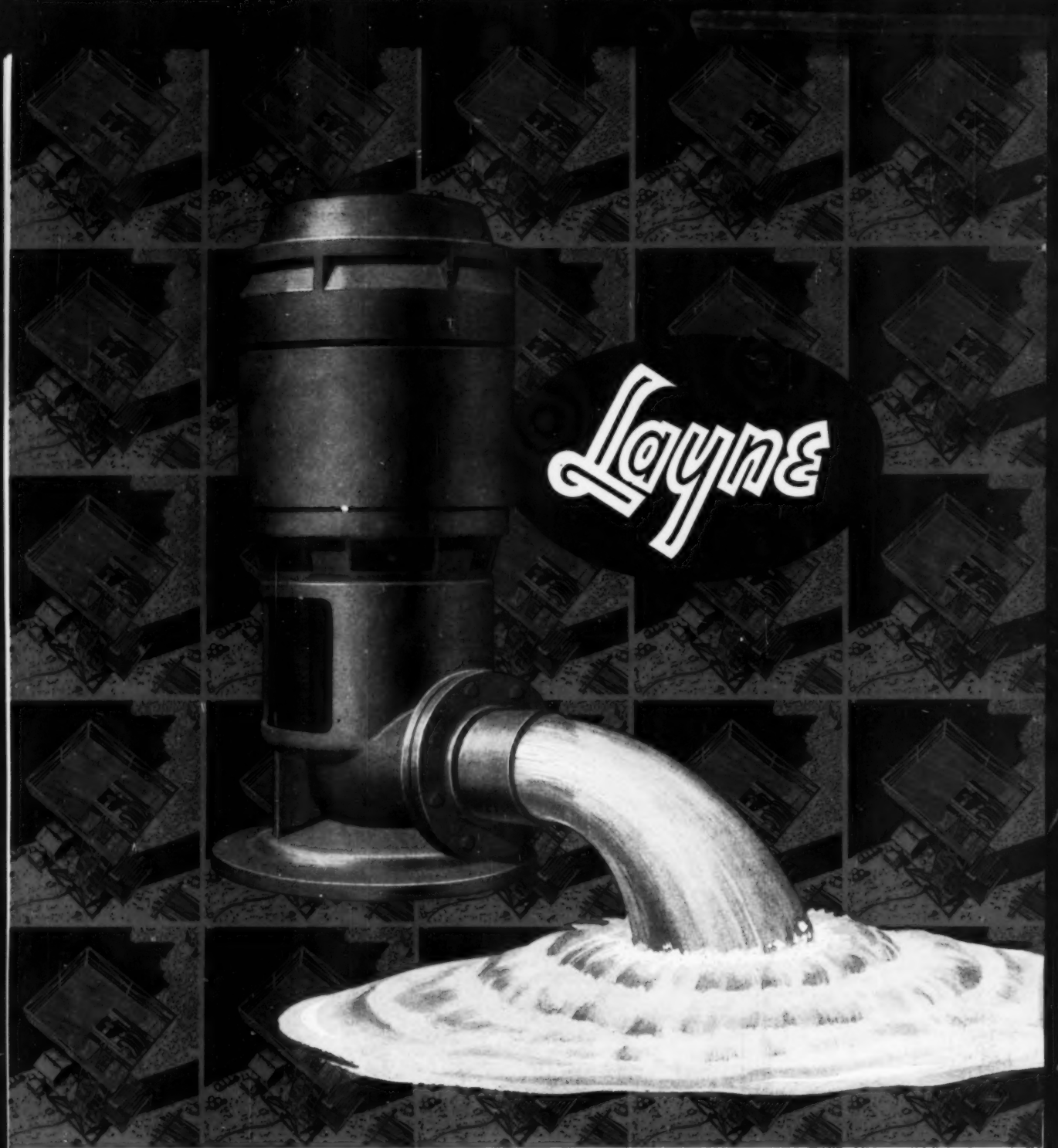
ORIFICE METERS

Versatile American® Series A-88 mercury-type orifice meters meet the toughest flow measurement requirements – working pressures to 5,000 psi – interchangeable 10, 20, 50, 100 and 200-inch ranges. Recording meters may be equipped with 0-150° F. standard temperature element. Integrating meters integrate static and differential pressure, providing totalized flow indications. Telemetering equipped meters transmit integrated indications to remote locations.

- Manometer body easily cleaned – does not affect calibration.
- Tamper-proof calibration – simple, positive adjustment of float lever arm length.
- Interchangeable ranges – no manifold piping changes.
- Teflon-packed stuffing box is pressure tight, nearly frictionless, never needs lubrication.
- Teflon-packed pulsation dampener externally adjustable under full line pressure.
- Check valves give positive shut-off for over-range protection.

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1836)

General Offices: Philadelphia 16, Pa.
Sales offices in principal cities



Layne pumps top more producing water wells

Layne Pump Design, manufacture and installation are only part of the complete water service offered by the Layne organization. Other services include: Initial surveys, explorations, recommendations, site selection, foundation and soil sampling, well drilling, well casings and screens, gravel wall wells, construction of water systems, complete research staff and facilities, maintenance and service, chemical treatment of water wells, water treatment. *Write for Bulletin No. 100.*

WORLD'S LARGEST Layne WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

cost-cutting gas boosters

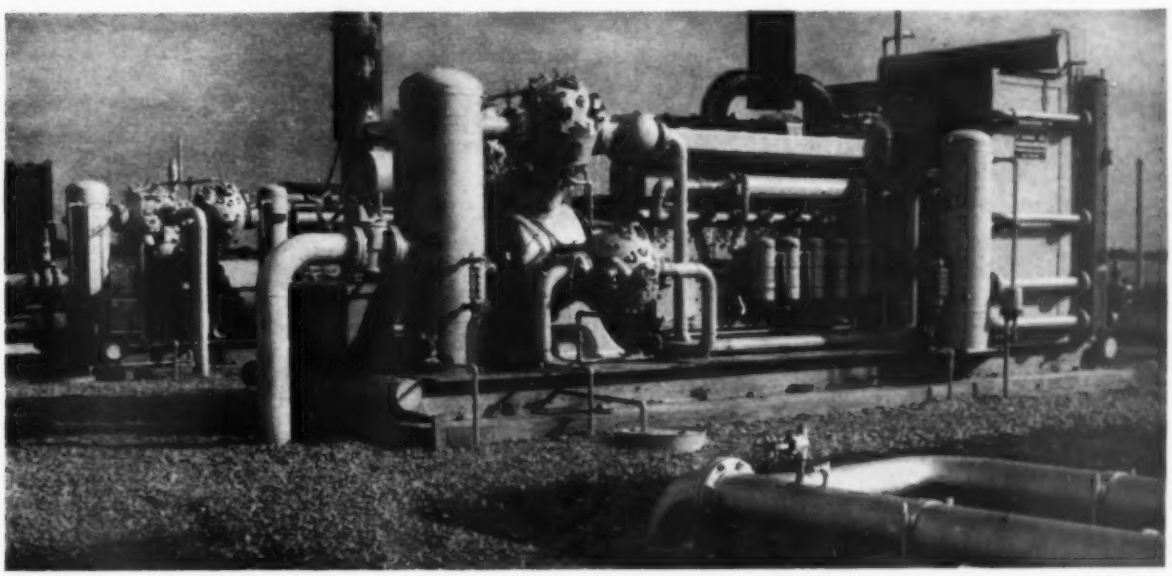
In a recent 12-month period, Sunray Mid-Continent Oil Company installed 11 "packaged" gas compressors, each dependably powered by a White Superior gas engine. Every day 4050 HP from the Superiors drives compressors that deliver 37,475,000 cubic feet of gas for Sunray's expanding gathering program!

Throughout gas and oil fields, rugged, compact Superior engines are proving economical, both in purchase price and operating costs. For example, because of the ability of Superior engines to deliver required HP at low speeds, the engines are directly coupled in engine-compressor packages. This eliminates the need for expensive gear reducers, results in smooth continuous performance and low fuel consumption.

Superiors' extreme design simplicity, precision construction and many advanced engineering refinements reduce maintenance and repair and greatly prolong engine life.

Superior engines are available in diesel, dual-fuel and gas engines from 190 to 2150 HP and in portable or stationary generator sets from 150 to 1500 KW. Get complete information from leading oil field distributors, White oil field representatives, or through White Diesel Engine Division.

Sunray Mid-Continent expansion program includes 11 new Superior-powered compressors

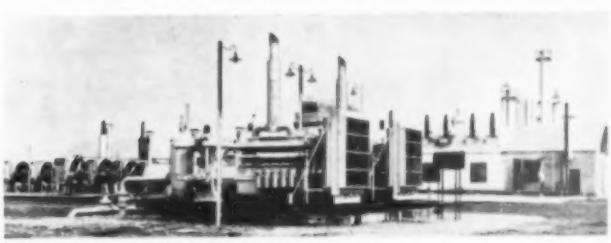


Superior ATLAS Imperial DIESEL ENGINES White DIESEL

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

Superior 8G-825 eight-cylinder gas engines driving gas boosters at Sunray's West Moore Field, Cleveland County, Oklahoma.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Trade Parade

MALONEY-CRAWFORD Tank and Manufacturing Company has purchased the Union Tank Division, Houston, Texas, of Butler Manufacturing Company, Kansas City. R. C. Schenk, Maloney-Crawford president, and John A. Morgan, president of Butler, made the announcement. Union Tank's engineering, product and field sales operations will be integrated with Maloney-Crawford's Tulsa headquarters. Butler, for a limited time, will continue to manufacture products for Maloney-Crawford. Willard H. Land, newly appointed vice president and sales manager of Maloney-Crawford, will direct the combined sales force and service operations.

PETROLEUM ELECTRIC POWER ASSOCIATION. New officers for 1959-60 term are: Incoming president — D. S. Coffman of Texas Power & Light Company, Dallas; vice president — W. M. Larkin of Gulf States Utilities Company, Lake Charles, La.; secretary-treasurer — B. F. Thompson of Public Service Company of Oklahoma, Tulsa.

New directors are: Langston Ashford, Central Power & Light Company, Corpus Christi, Texas; W. M. Larkin, Gulf States Utilities Company; Paul Atwell, Mississippi Power & Light Company, Jackson; B. F. Thompson, Public Service Company of Oklahoma; Jas. E. Moody, Southwestern Electric Power Company, Shreveport, La.; D. S. Coffman, Texas Power & Light Company; Harold S. Nay, Kansas Gas & Electric Company, Wichita; J. L. Satterfield, Pacific Power & Light Company, Wyoming Division, Casper; John Odom, Texas Electric Service Company, Midland, Texas; Paul B. Ferris, Empire District Electric Company, Joplin, Mo.; Kirby Dawkins, West Texas Utilities Company, McCamey, Texas; Roger K. Owen, Southwestern Public Service Company, Amarillo, Texas.

TOOLS MANUFACTURED IN AUSTRALIA. For over a year J. A. Frates, president of The Ridge Tool Company, Elyria, Ohio, has been directing negotiations for the licensed manufacture of world-famous Ridgid pipe tools for distribution in Australia and New Zealand. These negotiations were successfully completed with the P. T. Tools Division of G. N. Raymond, Ltd. Peter W. Tritsch, manager of P. T. Tools, Melbourne, Australia, will direct the manufacture and sales.

BUILDING HAWAIIAN PLANT. Construction of a steel pipe fabricating and processing plant in the Hawaiian Islands has been started by the Southern Pipe Division of U. S. Industries, Inc., Azusa, California. George F. Yackey, for 12 years manager of the Fallbrook, Calif., public utility district, has been named project manager for Southern Pipe's Hawaiian construction program. The new plant is located on a 4-acre plot in the Campbell Estates Industrial Tract at Barbers Point on the south coast of the Island of Oahu, west of Pearl Harbor.

AGENT APPOINTED. Garrett Oil Tools, division of U. S. Industries, Inc., has announced the appointment of a new agent to handle the sales of Garrett relief valves, diaphragm control valves, and other industrial and pipeline equipment.

This new agent is the Thomas J. Campbell Company, 1485 Bayshore Blvd., San Francisco 24, Calif., which will handle this equipment in Northern California and Western Nevada.

FORMS FLIGHT TEST CENTER. Texas Instruments Incorporated has set up an Avionics Flight Test Center in newly acquired facilities at Addison Airport. The test center will bring together electronic and mechanical laboratories, engineering offices and airport facilities for more efficient flight-testing of airborne electronic systems which are developed and manufactured by the Apparatus division.

ACQUIRES INTEREST. Schlumberger Ltd. has acquired an 80 percent stock interest in Computer Systems, Inc. of New York City. Under the stock acquisition plan an amount of over $3 million will be invested in expanded production facilities, additional personnel and furthering of Computer Systems' research and development program.

Forty young scientists are being helped to get an education in 1959-60 through $58,200 in scholarship and fellowship grants made by the Schlumberger Foundation of Houston. Seven of these grants were for graduate study; 33 were scholarships for undergraduate study.

NEW CORPUS OFFICE BUILDING. Southern Engine & Pump Company has purchased land for a new office building in the Corpus Christi branch offices. The building will house the local sales offices, parts department, warehouse and service department. J. E. Kelly, formerly of the Dallas offices, was transferred to Corpus and is manager of that branch. N. M. Shuyler of Houston is in charge of the service department.

WELL LOGGING MOVIE. A new full-color movie explaining in simple terms the complex techniques of oilwell logging has been produced for the oil industry by Welex, Inc. Titled "The Oilman's Prophet, a new look at logging," the 22-min film will be shown during the summer in London and Milan, Italy, at well log interpretation schools to be conducted by Dr. S. J. Pirson of Austin, Texas, and Denver consultant Jack Grynberg. The movie is available for loan to oil companies and other organizations through Welex offices.

WILSON ESTABLISHES DIVISION. Wilson Supply Company has established an International Division. The new organization will be active in the oilfield equipment market with representatives in all major overseas oil producing areas.

The company has opened a New York International Sales office at 45 Rockefeller Plaza. Charles Remington has been appointed manager.

Wayne Harris will manage the Latin American sales for the Wilson Supply International. He will headquarter at the company's main office, Houston, Texas.

MOVE FROM MIDLAND. Relocation of The Western Company's general office facilities in Fort Worth was announced. The company will occupy space in the Fort Worth Club Office Building at 7th and Throckmorton streets. Slightly more than 30 of Western's 585 employees will relocate at the new offices. The Midland division office will employ some 55 persons in sales, technical services, warehousing and other functions.

NEW CHEMICAL DEVELOPMENT DEPT. Universal Oil Products Company has formed a new chemical products development department. Manager of the new department is Richard P. Schoenenberger, formerly manager of UOP's McCook, Ill., manufacturing plant. He will be assisted by John O. Iverson and Frank Stolfa. Schoenenberger will report to Marcus R. Schrein, vice president of manufacturing.

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with Catawissa '502' Check Valves
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Flow line or pipe line use . . . vertical or horizontal . . . no extra fittings for installing . . . full opening for flow of fluid or cleaning mechanism . . . easy to inspect, repair or replace parts . . . self cleaning . . . dependable . . . fully guaranteed.
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J-M DISTRIBUTOR NAMED. M. J. Crose Manufacturing Co., Inc., was appointed distributor of the complete line of Johns-Manville fiber glass pipeline products in addition to J-M asbestos felts previously handled. The J-M fiber glass line, including "Blue Flag" reinforcing pipe wrap, "Duramat" outer wrap, and "Duratape" and "Duramesh" hand wraps, was formerly manufactured by L.O.F. Glass Fibers Company, recently merged with Johns-Manville.

▸ **D. W. Onan & Sons Inc.** William J. Auger was named sales promotion manager. George Burda, who has headed the combined advertising and sales promotion departments, will continue to direct and administer all of the operations for which he has been responsible at the factory. His new title will be advertising manager.

J. C. Robinson of Harrison Equipment Co., Inc., Houston, distributor for D. W. Onan & Sons, Inc., is one of ten distributors selected to participate in an expanded management planning program by Onan.

▸ **Texas Instruments Inc.** Dr. F. Kenneth Brasted, former president of the University of Dallas, has joined TI as administrative director of the central research laboratory. Dr. A. W. Wortham, manager of the quality assurance department of the Semiconductor-Components division has been elected executive director of the American Society for Quality Control. Richard C. Wood joined the company as marketing manager, advanced technologies, in the central staff marketing division.

▸ **Youngstown Sheet & Tube Company.** Promoted to new positions at the Indiana Harbor works are: Clyde M. Horan, appointed general superintendent of basic steel operations at both the Indiana Harbor and South Chicago works; Donald M. Lloyd, named general superintendent of steel plant rolling and finishing mills, and Robert M. McCafferty, promoted to superintendent of continuous butt weld tube mills.

Also named was Charles W. White Jr., superintendent of bloom, billet, bar and skelp mills at Indiana Harbor.

▸ **Wolverine Tube division of Calumet & Hecla, Inc.** Bruce C. Doering was appointed sales representative in the Cleveland district. Formerly sales representative in the general sales office, Mr. Doering will now service northern Ohio.

A new district sales office and mill depot have been opened in Norridge, Illinois. The new office facilities will service Greater Chicago and the surrounding midwestern area. The mill depot operation will be coordinated by George E. Reade.

▸ **Erwin Wasey, Ruthrauff & Ryan, Inc.** Eugene B. Brien, nationally known petroleum marketing research expert, was appointed an assistant research director. Dr. Brien originally joined Texaco Inc. in 1955 as a consultant. Prior to that, for 2 years, he was Eastern editor of *The Petroleum Engineer*.

▸ **U. S. Industries, Inc.** Dr. William C. Knopf was named technical director of the USI Technical Center, Pompano Beach, Florida, research and development division of U. S. Industries. Prior to his new appointment, Dr. Knopf was assistant director of research at International Minerals and Chemical Corp.

▸ **Tretolite Company of California,** division of Petrolite Corporation. Louis T. Monson, general manager, was named a vice president of Petrolite.

▸ **Schlumberger Well Surveying Corp.** F. W. Benzley was transferred from Medicine Lodge to Pratt, Kansas, as location manager. G. G. Kemp of Shawnee, Oklahoma, is now serving as sales engineer there.

▸ **Tyson Smith Company.** Lester Farley has joined the company as a sales engineer. He will cover the San Antonio, Victoria, and surrounding areas from the Corpus Christi sales office. L. M. (Matt) Bracewell, sales engineer, has been transferred from the Lafayette-New Orleans area to Dallas. Walter W. Kincaid also is a new sales engineer with Tysco. He will work the Beaumont area.

▸ **Security Engineering Division,** one of the Dresser Industries. John C. Helies was appointed president. He was formerly executive vice president and general manager.

Claude L. Griffin was named vice president in charge of sales, formerly serving as domestic sales manager. A. R. (Pat) Patton was named division special sales representative. Patton joined Security International C.A. as district sales manager for Eastern Venezuela.

▸ **Oil Well Supply Division,** U. S. Steel. Formerly Rocky Mountain Area manager for "Oilwell," R. L. Armstrong becomes director of Oil Well Supply Company, Ltd., with offices in London, England. Replacing him at Casper will be A. S. Finefrock, who previously served as district manager at Billings, Mont. L. L. Mitchell was named treasurer. He was formerly assistant treasurer.

Lewis Y. Poland is store manager at El Dorado, Kans. Harold Leroy McDaris is field representative at El Dorado, Kansas and Billy Eugene Wright is field representative at Pampa, Texas.

NEW HEAVY-DUTY
AIR STARTING MOTOR
50% MORE POWER...
USES 30% LESS AIR...
10 LBS. LIGHTER...
SIZE 10 BM Air Starting Motor (for diesel displacement from 400 to 2300 cu. in.—gas or gasoline from 800 to 4600 cu. in.).
Outperforms all other air starting motors of comparable size. Fully interchangeable with electric starters, with these important advantages:
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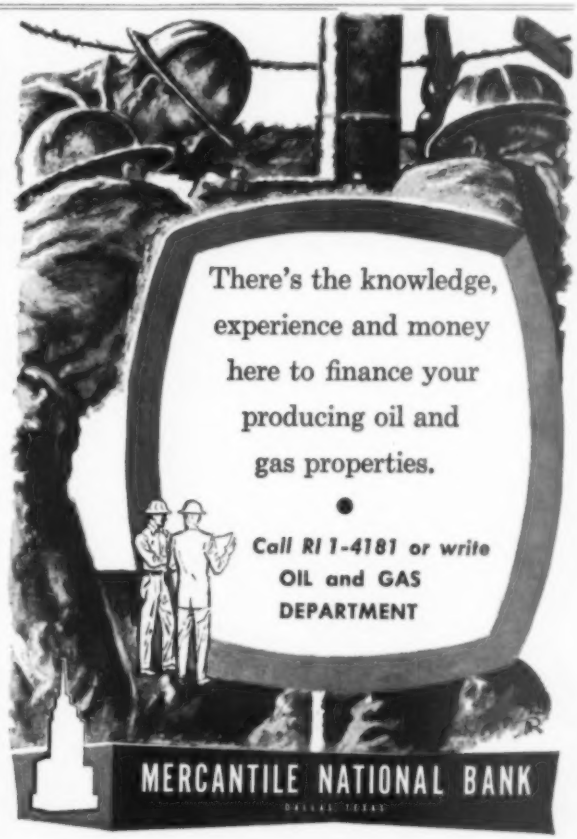
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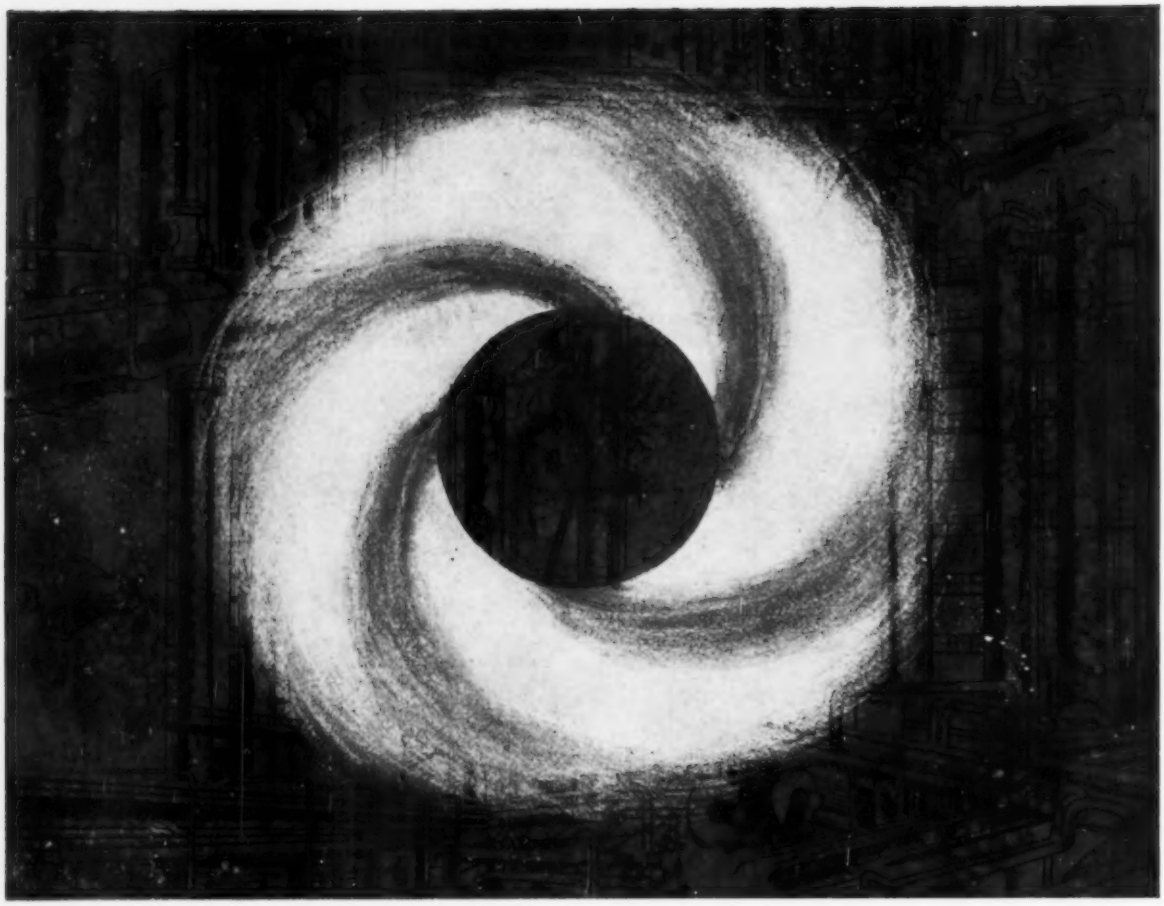

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ENGINEER-CONSTRUCTOR

Of the total installations in the world, one out of every three gas turbine compressor drives used in the petroleum industry has been designed by Brown & Root. Today, over 1,735,000 horsepower of the relatively new gas turbine drive is at work in various branches of the industry.

With its own forces, Brown & Root has installed 75 per cent of the units it has designed, and is familiar with — and has used components of — all U. S. and many foreign gas turbine manufacturers.

In the over-all field of gas compression and power generation, Brown & Root has designed and installed a total of 1,620,000 horsepower.

If you are planning a gas turbine installation — anywhere in the world — your inquiry will receive our prompt attention . . . with no obligation.

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MARACAIBO, VENEZUELA

EDMONTON, ALBERTA
CABLE ADDRESS -- BROWNBILT

W. C. Norris, Manufacturer. J. E. "Ed" Giles has been appointed Oklahoma division sales manager. He was northern Oklahoma and eastern Kansas field representative and has served as the company's city sales representative in Tulsa.

National Tube Division, U. S. Steel. J. Wayne Lindquist was named manager of standard pipe products.

NORTH TEXAS (DALLAS) CHAPTER of the National Industrial Advertisers' Association has elected Dan Goodrich, a Dallas agency executive, as president of the organization for 1959-60. Richard M. Perdue, Texas Instruments, Inc., and R. A. Surrey, Johnston Printing Co., were elected vice presidents. New secretary is Gene Garner, Continental-Emsco Co.; C. A. Nicholson, Chance Vought Aircraft, Inc., is treasurer, and Charles M. Clough, Texas Instruments, is sergeant-at-arms.

Minneapolis-Honeywell Regulator Co. Harry D. Ruch was appointed product sales manager for the newly developed line of electric instrumentation.

Henry F. Dever, vice president in charge of industrial products group, has been awarded an honorary doctor of science degree by Bradford Durfee College of Technology in Fall River, Mass.

J. Ernest Smith, vice president and director of the Datamatic division of Minneapolis-Honeywell, has been awarded an honorary doctor of science degree from his alma mater, Jamestown College in North Dakota.

Rockwell Manufacturing Company. Gilbert T. Bowman, assistant vice president of Meter and Valve Division, has been elected a vice president of the company. He will be in charge of the international division and petroleum and industrial division. Thomas F. Haskins, supervisor of the accounts payable department, was named senior buyer of the general purchasing department.

Formation of a new executive department — governmental relations was announced with I. C. Rowe, formerly corporate secretary, named to direct it.

Joseph A. Mark joined Rockwell as advertising manager of the power tool divisions; W. Richard Bleichner was named advertising manager, meter and valve and petroleum and industrial divisions; William H. Douglass Jr., has been promoted to advertising manager, municipal and register divisions and Clifford A. Thompson has been appointed editor-in-chief of Rockwell's eight publications.

Republic Creosoting Company. Carleton B. Edwards was elected to the newly created position of, and will remain active as chairman of the board of directors of Republic and its subsidiary, Reilly Tar and Chemical Corporation, both Indianapolis. Peter C. Reilly has been elected president of the two companies, and Thomas E. Reilly, continuing as vice president, will also serve as treasurer.

Petro-Chem Development Co., Inc. John J. Griffin has been appointed chief engineer. He was formerly manager of the service department.

Pipe Linings, Inc. Forest E. Foster has been made a special salesman to the oil industry. Foster has been working regionally as salesman.

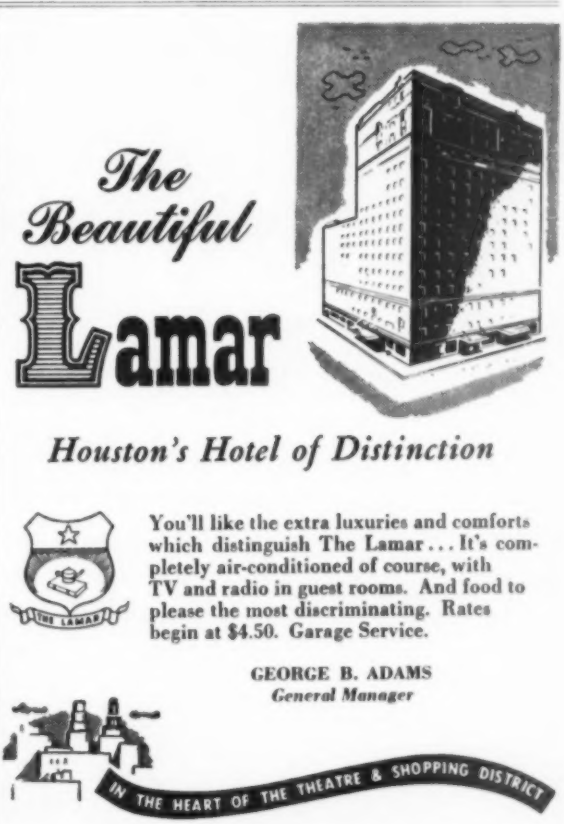
Motorola. Irving Koss was named manager of the microwave department and industrial control products department of Motorola's Communications and Industrial Electronics Division. He succeeds Roy H. Olson who is now general manager of the company's Chicago Military Electronics Center.

Mandrel Industries, Inc. D. D. Mize was elected to the board of directors. Mize, a vice president, is general manager of Mandrel's Houston operations consisting of The Electro-Technical Labs Division. Stockholders elected William Matson Roth, Stirton B. Parker and Waldron E. Wilson to the board. Re-elected to serve on the board were James R. Lowe, chairman; George Quist, president; James F. Coonan and William W. Valentine.

Baroid Division National Lead Company. B. L. Boccella was appointed assistant manager operations in the general offices at Houston, Texas. Boccella was formerly manager of Baroid's Mid-Continent area at Tulsa. Replacing Boccella is Kemp S. Lewis, formerly assistant area manager in the Lower Texas Gulf Coast area with offices in Corpus Christi. R. K. Epps Jr., was named assistant chief drilling mud engineer with headquarters in the Houston offices. G. G. Allen, formerly district superintendent in the Louisiana Gulf Coast area, as assistant manager of the Lower Texas Gulf Coast area in Corpus Christi. He previously served as area engineer of the Texas Gulf Coast area. J. M. Bugbee Jr. is assistant manager of the Lower Texas Gulf Coast area in Houston.

Dr. John W. Jordan, technical director for Baroid, was awarded an honorary ScD from Marietta College, Marietta, Ohio. Dr. Jordan, who holds his PhD in chemistry from Columbia University, graduated from Marietta College in 1934.

Marsh Instrument Company. Bernhard Willach was elected president for engineering. During the past 17 years he has served as chief engineer.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Here's the *safer* tape the oil industry needs for jet fuels. Stainless steel line is Chrome Clad®. Handle is wood. All other parts are non-sparking metals. See your Lufkin dealer for this new oil gaging tape.

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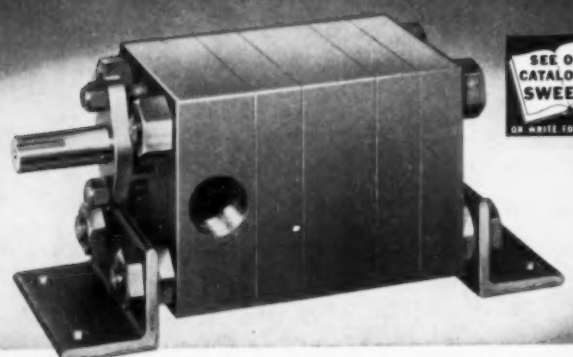
Lube oil, seal oil and fuel oil pumps for compressors and engines



Complete range in pump sizes from ¼ GPM to 146 GPM. Pressures to 2000 PSI. Proven in thousands of installations and backed by 50 years of engineering and production experience, Northern Steel Block Nitralloy Rotary Gear Pumps are unexcelled for precision manufacture, accurate assembly and dependable, long life operation. Write for free catalog and engineering data.

NORTHERN ORDNANCE, INCORPORATED
Subsidiary
NORTHERN PUMP COMPANY
MINNEAPOLIS 21, MINN.

Trade Parade

Clayton Mark & Company. Roy W. Gronauer was named sales manager of industrial fittings succeeding T. Bruce Cox who resigned recently. Gronauer was formerly sales vice president of the OPW Corporation.

Cooper-Bessemer. Earl Martin was named branch manager of the Houston office. He fills the post vacated by R. H. Dale who retired.

C. R. (Bob) Jones is named general manager, Cooper-Bessemer of Canada, Ltd. Presently vice president and western district manager, Jones also was elected to the board of directors of Cooper-Bessemer of Canada. Leopold A. Ffrench was appointed to the Cooper-Bessemer International Corporation office at New York City.

Harry A. Cecsarini is new European manager of Cooper-Bessemer Societe Anonyme, a Swiss company incorporated in Chur, Switzerland, with offices at The Hague, Netherlands.

Mid-Continent Supply Co. Alan A. Pike was promoted to district sales representative in Fort Worth. He was formerly district manager in Casper, Wyoming. Named as store manager in Duncan is George N. Magee. Magee has served as a field sales representative and city sales representative.

Clark Bros. Co., one of the Dresser Industries. John N. Mackendrick, president, has been appointed chairman of the board succeeding C. Paul Clark who was named honorary chairman. F. W. Laverty, executive vice president, was named president and Joseph J. Rosecky, vice president in charge of operations, was made executive vice president.

Chicago Bridge & Iron Company. H. C. Brown, vice president, has retired after more than 43 years, but will remain a member of CB&I's board of directors.

Milwhite Mud Sales Company. Ernest Holy, administrative vice president, and Sidney A. Adger, vice president of public relations and sales were elected to the board of directors.

Mission Manufacturing Company. W. C. Talbert was named director of foreign sales with headquarters in Houston. He was sales manager for the Mission Manufacturing Company, Ltd., with offices in London.

Cameron Iron Works, Inc. Troy C. Stedman was appointed West Coast regional sales and service manager of the oil tools division.

Christie, Mitchell & Mitchell. George P. Mitchell is the new president. Mitchell, a geologist and petroleum engineer, succeeds his brother, Johnny Mitchell, who becomes vice chairman of the board, with H. Merlyn Christie as chairman.

McCullough Tool Company. Olin McGrew was appointed district sales and service manager at Farmington, New Mexico. He formerly was district sales representative at Farmington.

Collins Radio Company. J. C. McElroy was appointed director of development; Dr. R. L. McCreary as director of research, W. W. Roodhouse as director of sales and A. S. Born as an assistant to R. T. Cox, vice president in the newly organized Cedar Rapids Division.

E. A. Williams continues as controller; G. G. Johnson as head industrial relations; and J. H. Wagner heads purchasing.

American Meter Company, Inc. Albert L. Weldy was named sales representative for the Birmingham sales district, with headquarters in Pompano Beach, Florida.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Trade Parade

Chemetron Corporation. Howard D. Hartough was elected president of the Chemical Products Division. He was formerly general manager of Girdler Catalysts, a division.

United States Army Chemical Corps. W. Ward Jackson, vice president of Commercial Solvents Corporation, was paid a special tribute for "his energetic support of the Chemical Corps' Industrial Liaison program." Jackson was given a plaque and certificate of achievement for outstanding contributions to the Corps in ceremonies at the Army Chemical Center, Edgewood, Maryland.

Continental-Emsco Company. Frank Ellis has been appointed store manager of a new store at Lafayette, La. The new sales outlet will be under the supervision of Noble D. Lane, district manager, and E. A. Dunn, division manager.

Youngstown Steel Products Company of California. J. A. Crawford, president, was appointed an executive vice president of Continental-Emsco Company, a division of The Youngstown Sheet and Tube Company, and will also continue as president of Youngstown Steel with headquarters at Los Angeles. Under the direction of Crawford, Continental-Emsco will represent Youngstown Sheet and Tube in California in the distribution of Youngstown's complete line of oil country tubular products.

R. I. Whelan, C. C. Dunseth, W. R. Clardy, W. C. Grimsted, J. W. (Joe) Rodgers and Richard Graham, serving as tubular representatives of Youngstown Steel, will continue in the same capacities with Continental-Emsco. W. C. Kinder, a vice president of Continental-Emsco at Dallas, will move and headquarter at Los Angeles, where, under the direction of Crawford, he will supervise Continental-Emsco's expanded operations. L. M. Bush, division manager of Continental-Emsco's California division, will continue in his present capacity, with headquarters in L.A.

F. M. Mayer, president of Continental-Emsco Company, stated his company's confidence in the future of the California oil and industrial markets prompted the expansion of facilities. Three new stores, at Los Angeles, Bakersfield and Ventura, have been added, which are in addition to D+B production stores operating in Long Beach, Santa Fe Springs, Coalinga, Taft and Oildale.

Hunt Tool Company. The opening of a new sales and service point in Morgan City, La., was announced with Ford de Cordova heading the new outlet as district manager. Thomas A. Kennard, formerly a sales representative in the Houston area, replaces de Cordova as district manager in the Jennings office.

Andrew Corporation. C. Robert Lane was promoted sales manager. He has been associated with the company for 4 years as Eastern regional manager, with offices in Westwood, Massachusetts.

Grant Oil Tool Co. Rex Walling was promoted to field supervisor in charge of branch operations. Walling joined Grant in 1951 after 17 years in geophysical work. He was district manager and division manager at Odessa before his new assignment. Succeeding Walling as district manager at Odessa is Les Hanson, who has been a representative in Odessa and in Oklahoma City since 1952. Robert S. Miller, veteran oilfield supply salesman in the Rocky Mountain area, is now a Grant representative at Casper, Wyoming. Nolan Byrd, former branch manager for a large supply firm in Farmington, N. Mex., has been added to the Odessa sales staff.

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Here's Why . . .

They are specifically designed to overcome the unusual conditions of Oil Field requirements, and there is a type and H.P. built to fit your exact needs. Unexcelled since they are . . .

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- CORROSION RESISTANT
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SEMI-ENCLOSED — normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings in semi-enclosed protected housing, 40 degree C rise. Built for continuous duty. **High Torque, low starting** current. Extra insulating coating throughout.

TOTALLY ENCLOSED — Fan cooled, normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings, totally enclosed FAN cooled 55 degrees C rise, for continuous duty. High Torque — low starting current. Extra insulating coating throughout.

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Manufactured by Valley Electric Corporation, St. Louis 8, Mo.

WHEELING

COUPLINGS

FOR OIL COUNTRY USE

LINE PIPE COUPLINGS — ⅛" to 12" — Seamless — Black or Galvanized

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REAMED AND DRIFTED A. I. S. I. — ¾" to 12" — Seamless

DRIVE PIPE COUPLINGS — 6" to 12" — Seamless

PIPE NIPPLES — All Sizes and Types

STEEL BUSHINGS AND PLUGS — Merchant and High Pressure

WHEELING MACHINE PRODUCTS COMPANY

WHEELING, WEST VIRGINIA

WEST COAST FACTORY: WOODLAKE, CALIFORNIA

Part of J. P. Neill's spread at work on a line near Laurinburg, N. C. An official of the company reports: "The No. 572 is the best all-around pipelayer you can put on any spread. We know from experience it will handle hard jobs with ease."

TOUGH PIPELAYING PAIR

These are just two of a number of Caterpillar Pipelayers used by J. P. Neill on the North Carolina Natural Gas Corporation's line near Laurinburg, N. C. A D7 is lending a hand through swampy ground that, along with rolling hills of sandy clay, makes up the right of way. The spread's on schedule—just what you'd expect with these pipelayers.

Big features on this tough pair account for their productivity . . . plenty of dependable engine horsepower to push the machines through hard going like this with power left over to handle a long string of heavy pipe.

The No. 572 Pipelayer shoulders 86,000-pound lifts and maneuvers with finger-tip ease . . . thanks to hydraulic boosted steering. The torque converter drive lets the pipelayer inch along with full power.

The MD7 is close to the No. 572 in lift capacity and features. The same hydraulic boosted steering system plus the easily engaged and disengaged Cat exclusive oil clutch account for the ease of maneuvering the MD7. And that famous oil clutch typically gives an entire hard-work season without even an adjustment. Both machines take top awards in dependability and high production at low cost with less job time for maintenance.

SEE YOUR CATERPILLAR DEALER

Get the facts about these two rugged pipelayers and learn about the other Caterpillar machines that have earned *and maintain* the reputation for high production at low costs even in the worst conditions.

Ask your Caterpillar Dealer for a demonstration. Make it rough—see for yourself how easily Cat machines handle the hard work.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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TOUGH MACHINES
FOR THE HARD WORK

August 27, 1959—Oil's 100th Birthday

A Great Day for Every Oil Man and Woman

100 years ago Colonel Edwin L. Drake drilled the first commercially successful oil well.

Of all the many uses for petroleum during the past century—as an illuminant, a lubricant, a source of chemicals—its most important use has been *as a source of abundant, low-cost energy*.

The progress of any nation can be measured by the amount of energy it consumes—for heat, light, transportation, agriculture, industry.

We in America produce and use 40% of all the energy consumed in the world—enjoy the highest standard of living in the world. More than two-thirds of our energy comes from oil and natural gas.

By August 27, 1975, America's energy needs will have doubled. Oil and natural gas will be called upon to supply two-thirds of this need—or 30% more energy than we now derive from all energy sources combined.

Every oil man and woman shares a quiet pride in the progress of our first century—and confidence in our ability to meet the challenges of the second.

As we look ahead to our second century, we join all other American business and industry in giving thanks for America's unique climate of freedom—from which all *past* success has come . . . on which all *future* success depends.

Committee on Public Affairs
of the
American Petroleum Institute
50 West 50th Street • New York 20, New York

BURGESS-MANNING

SNUBBER NEWS

Dedicated to the Elimination of Pulsation and Intake and Exhaust Noise

Snubbers Used to Quiet Compressor Engines

Burgess-Manning BES-12 Exhaust Snubbers, installed on engine compressors at Continental Oil's West Short Junction Plant, are eliminating excessive exhaust noise.

The West Short Junction Natural Gasoline Plant, owned by Continental Oil Co., in Cleveland County, Oklahoma, is one of the most efficient plants of its type in this country. Operated by only two men, it is noteworthy for both its low operation and maintenance cost and the many unusual operational features that contribute to its efficiency.

Among the distinguishing features of the plant is the absence of excessive exhaust noise from the 13-550 HP engine-compressors. Aware, through experience, of the high noise level of the exhaust from such a battery of compressors, Southwest Industries, Inc., who supplied the compressors, included a Burgess-Manning BES-12 Exhaust Silencer with each unit. The silencers are installed vertically at the end of the exhaust manifold so that the exhaust is discharged well above the roof. Considering the number and horsepower of these compressors, the West Short Junction plant is one of the quietest, as well as most efficient, plants in the Petroleum industry.

If you have an exhaust or intake noise problem, or a pulsation condition that causes dangerous vibration in a closed pipe line system, you will find it profitable to consult Burgess-Manning engineers for an effective solution.

Cross section of a typical Burgess-Manning Snubber, similar to the type used at Continental's West Short Junction Natural Gasoline plant.

BURGESS-MANNING COMPANY

Sound Engineering *Industrial Silencer Division*

9241 Sovereign Row, Dallas 35, Texas
Libertyville, Illinois

Books to Read

The Great Oildorado, *by Hildegarde Dolson. Published by Random House, Inc., 457 Madison Avenue, New York 22, New York. Pages, 300. Price, $3.95.*

For the petroleum industry's 100th anniversary, "The Great Oildorado" is a fitting and entertaining tale. It gives a breathless account of the first oil boom in Pennsylvania, stretching from 1859 to 1880, and has some interesting background of the early over-night millionaires, playboys, and notorious citizens. One thing it will do for the modern oil man is make him realize the great stability that has been built in the industry over the 100 years of its history.

We were sorry to note that some of our favorites had not been mentioned in the volume and quite a bit of space was given to those who accidentally got oil money like Coal Oil Johnny, the compulsive playboy, and to a man with little interest in oil — John Wilkes Booth, Lincoln's assassin.

It is an interesting drama, however, this tale of a dramatic period at the beginning of a fabulous industry. The author grew up in Franklin, Pennsylvania, and has heard many of the anecdotes she tells since she was a child.

Calculation of Flowing and Static Bottom-Hole Pressures of Natural Gas Wells *(TPRC Bulletin 72), by Paul B. Crawford and George Fancher, published by the Texas Petroleum Research Committee, 201 Petroleum Engineering Building, University of Texas, Austin 12, Texas. Pages, 198. Price, $5.*

The manual outlines procedure developed by the TPRC to facilitate the determination of the performance and potential of gas wells. The method, significant in that it makes use of surface calculations, increases the accuracy and ease in making such computations, as well as increases the reliability of the computations with the result that they can be checked, errors found and discrepancies ascertained.

The bulletin contains 142 graphs, figures and charts explaining the system by examples that are completely worked out. The Texas Railroad Commission has authorized the method in adjusting of absolute open flow for determination of the potential of gas wells by state Rule 24, and is also authorized for use in conjunction with the manual of the standard "Back Pressure Test for Natural Gas Wells for the State of Texas."

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Reclaim TANK BOTTOMS

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BRAKESOL holds paraffin in suspension! Inject it into gathering lines and BRAKESOL keeps them free of paraffin.

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Laugh with Barney

A golfer rushed up to the foursome and said "Pardon me, do you mind if I play through? I've just received word that my wife's been taken seriously ill."

By the time a man's wise enough to watch his step, he's too old to go anywhere!

Cannibal King: What am I having for lunch?
Cook: Two old maids.
King: Ugh, leftovers again.

An oil man had a friend who approached his lawyer and told him, "I won't pay you unless you are certain that there are grounds for legal action."

"Well, tell me the case," said the lawyer. The fellow explained the whole situation and when he got done, he looked at the mouthpiece and asked, "What do you think?"

"The case is airtight," the lawyer informed him. "The other fellow hasn't a leg to stand on. My advice is $100 and for an additional $150 I'll start suit."

"No," said the oil man, "I guess I'd better not."

"But why?" demanded the lawyer.

"Because I gave you the other fellow's side of the story!"

A mother had been trying to stop her son from sucking his thumb. So far she had been unsuccessful. One day she told him, "Son, if you keep sucking your thumb your stomach will get bigger and bigger until it will finally burst." That scared the boy and he stopped. One day his mother was entertaining some lady friends and one of them was pregnant. The little boy pointed her out and said in a loud voice to his mother, "I know what she's been doing!"

Jake came home in the middle of the afternoon. He was met at the door by his wife and his son. His son exclaimed, "Dad, there's a boogey man in the closet." Jake rushed to the closet and flung the door open. There, huddled among the coats was his partner, Sam. "Sam!" shrieked Jake, "why in the heck do you come here in the afternoon and scare my kid?"

Kay Kyser played before an audience of married people. He included in his program for newly-weds "Night and Day." For those who had been married a little longer he played "Now and Then." For those married twenty years he played "Once in a While." As he was about to play for those married fifty years an old man popped up in the rear of the house and said, "Before you play "Memories," play, "We Did it Before and We Can Do it Again."

"Do your children ever ask you anything about sex?"

"Yes. It amuses them to see how ignorant I am on the subject."

During the last day of a psychiatrists' convention, one of the doctors present at the closing lecture noticed an attractive female PhD being pawed by the man seated next to her. "Is he bothering you?" the gallant observer asked the woman.

"Why should I be bothered?" she replied, "It's his problem."

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FLORIDA'S
EAST COAST
RANCH STYLE FURNISHED APTS. AND MOTEL ROOMS—BRING YOUR FAMILY
Superb climate—seashore cool breezes. Finest fishing. Family fun—attended beach, barbecue areas, children's safe playgrounds. Shops, Restaurants, Golf and Sightseeing. 1, 2, 3 bdrm. Apts.
Rates include FREE use of:
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• Shuffleboard
• Fishing Dock
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Write Today For Rates and Information.
COMPLETE APARTMENTS FOR TWO $34.50 to Dec. 15
SHAMROCK VILLAGE
Ft. Pierce Beach, Florida

A vacation with fun on balmy Galveston Island—what could be a happier surprise for your family! Planned activities for all at the grand Hotel Galvez—Southwest's finest beach resort hotel.

FROM SUMMER'S HEAT

Children Free. No charge for youngsters in room with parents. For folder, write Mgr., Hotel Galvez, Galveston Island, Texas.

HOTEL GALVEZ

Swimming Pool, Air-conditioned, Radio-TV, Fine Food

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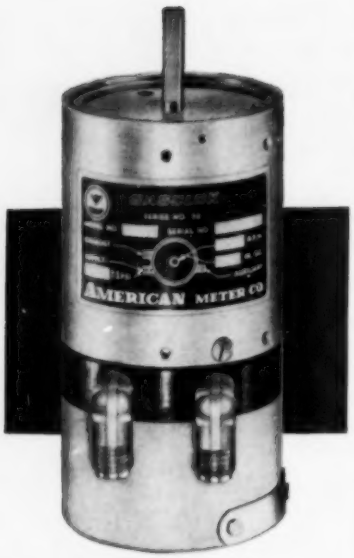

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Inherently explosion proof and self-starting, the GASCLOK is ideal as original or replacement equipment for strip chart and conventional circular chart instruments. The timing mechanism is internally sealed to prevent corrosion, and all power unit parts exposed to gas are aluminum or stainless steel. Large area internal ports prevent clogging. Normal air or gas consumption 5 cfh . . . operating pressure 5 psi . . . rotation 2 rpm.

AMERICAN®
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INCORPORATED (ESTABLISHED 1836)

Executive Offices: Philadelphia 16, Pa.
Sales offices in principal cities.

▸ **Camco, Inc.** Gilbert H. Tausch has recently joined Camco in the newly created position of director of engineering. He will be located in Houston and will supervise all engineering and research. Tausch was formerly with Humble Oil and Refining Company in well completion development work and reservoir engineering.

▸ **Clark Bros. Co.** Ernest G. Hotze was named Southwest district manager. Hotze has been Houston district manager. Joe Y. Allen, Jr., former assistant district manager succeeds Hotze. Also named as district manager under Hotze is James R. Hutton, who will be in charge of the newly created Louisiana-Mississippi district serving Southern Arkansas, Louisiana and Mississippi.

▸ **Dowell.** Howard Waugh, sales engineer has been transferred from the Calgary office to Charleston, West Virginia.

▸ **General Electric.** Kent J. Worthen was appointed national sales manager for two-way radio. From the company's Communication Products headquarters in Lynchburg, Va., he will direct the sales activities of 60 district offices throughout the nation and will coordinate the efforts of several hundred representatives who sell mobile radio equipment.

L. R. Sheeley, formerly manager of mobile radio equipment sales, was named national sales manager for the Computer Department in Phoenix, Arizona. Robert L. Casselberry, manager of product planning and marketing research for two-way radio for the past five years, has been named acting manager of the technical products operation of GE's Communication Products Department.

▸ **Hupp Corporation** has purchased the valve operator division of Cutler-Hammer, Inc. Manufacturing operations will be moved from Milwaukee to the Chicago plant of the Hupp Aviation Company division. Hupp Aviation will be responsible for service of Cutler-Hammer valve operators now in service. The Hupp-made product will be known as Electrodyne valve actuators.

▸ **Halliburton Oil Well Cementing Company.** Francis N. Harris, who has been a member of the analytical section, chemical research and development laboratories at Duncan, Oklahoma, has joined the company's production improvements section as staff engineer, chemical services. The production improvements section is headed by W. E. Hassebroek, formerly technical supervisor for fracturing.

Warren Barr was named training supervisor for Halliburton's northern region. He has been district superintendent at Vernal, Utah, and has also had 2 years experience as a division training supervisor.

▸ **Continental Carbon Company.** H. R. Wall, Houston, was elected president and chief executive officer. Formerly general manager of Continental Oil Company's transportation and supplies department, he succeeds Robert I. Wishnick, New York City, who has been elected to the newly created position of chairman of the board of Continental Carbon. Continental Carbon is owned by Continental Oil, The Shamrock Oil and Gas Corp., and Witco Chemical Co.

▸ **Lane-Wells Company,** one of the Dresser Industries. Kirby Gee, formerly vice president in charge of operations, was appointed to the newly created post of executive vice president. Jas. D. Hughes, vice president in charge of sales has been named special assistant to the president.

▸ **Baker Oil Tools, Inc.** P. E. Hilton, vice president and former central division sales and service manager, in Houston, Texas now has under his direction three new divisions (Southern, Northern, and Western), formed from the area that was the Central and Western divisions.

Hilton will be assisted in Houston by R. D. McBrian, who has been promoted to the position of assistant domestic sales manager. C. C. Taylor, formerly assistant central division sales and service manager, will be Southern division sales manager with headquarters in Houston. R. L. Turner, who was assistant Western division sales and service manager, will be Northern division sales manager with headquarters in Denver, Colorado, and G. M. Anderson will continue as Western division sales manager with headquarters in Los Angeles, California.

▸ **Black, Sivalls & Bryson, Inc.** Lawton L. Laurence was named general manager of Eastern Hemisphere oilfield operations and will be in charge of operations of Black, Sivalls & Bryson (Nederland) N. V., Black, Sivalls & Bryson (G. B.) Ltd., and Black, Sivalls & Bryson (France) with offices at The Hague, London and Paris.

Charles H. Myers, vice president and manager of the Oilfield Equipment division was appointed industrial relations vice president, and will work with division managers and subsidiary managers in further development of industrial relations and safety practices programs. Floyd C. Myers, vice president and manager of oilfield sales and service, has been appointed Houston vice president. Paul Bartley, vice president and general manager of Black, Sivalls & Bryson, Ltd., Edmonton was appointed to replace Myers in Oklahoma City.

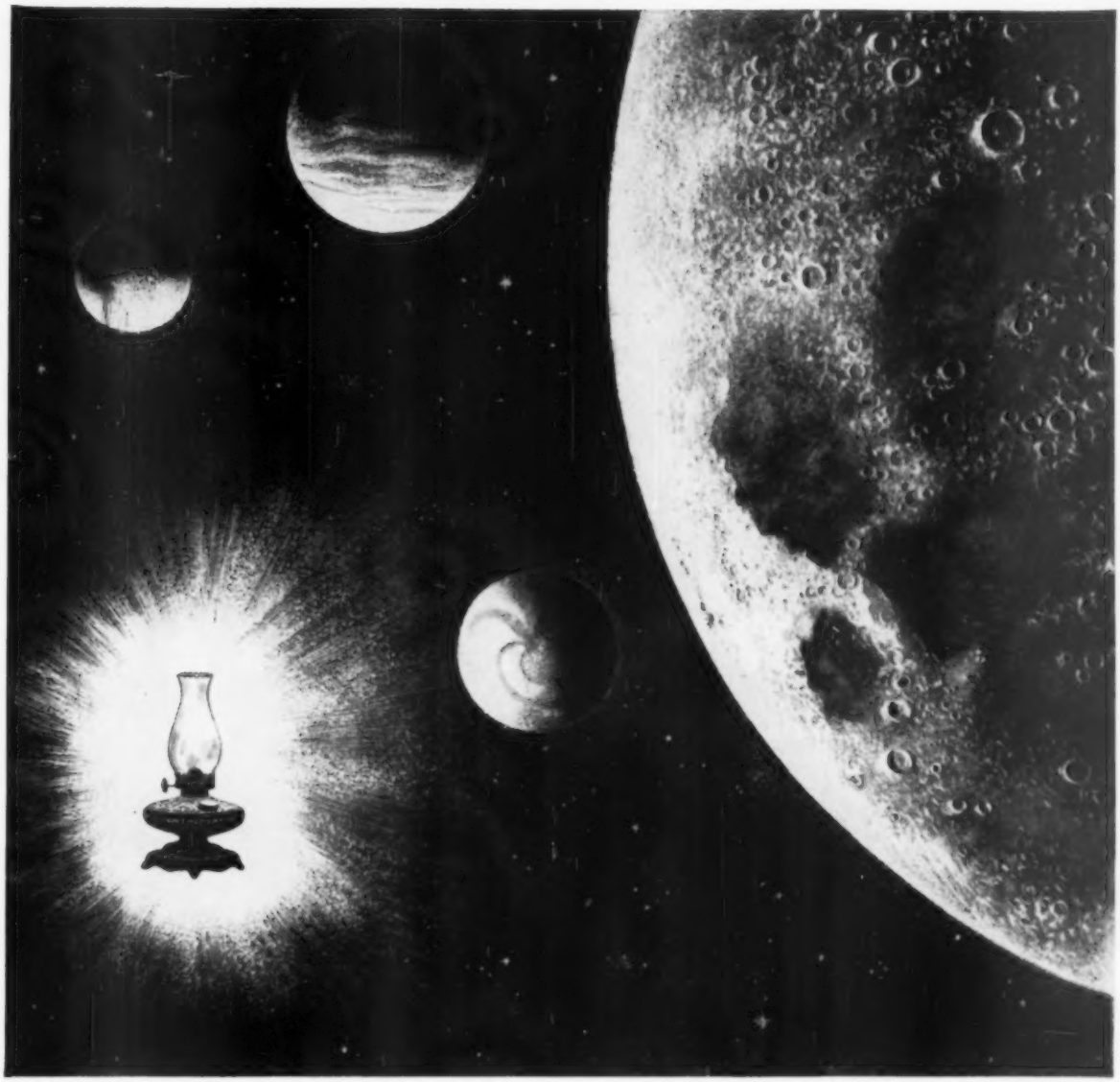
▸ **Blaw-Knox Company.** George E. Kopetz, vice president of production, was named vice president and general manager of the newly formed Fabricating, Engineering and Construction Group. Arthur E. Murton, formerly roll sales vice president, was named vice president and general manager of the new Foundry & Mill Machinery Group, and H. G. Coffey heads the company's third operating group as vice president and general manager of the Aetna-Standard Division.

▸ **Burndy Corporation.** John F. Jones, formerly president and director of H. H. Buggie, Inc., has been elected a vice president and director of Burndy, while George A. Goos, vice president and director of Buggie has become assistant secretary of the latter company. This follows the acquisition of Buggie by Burndy May 1.

▸ **Dresser Industries, Inc.,** has disposed of its interest in Hydrocarbon Research, Inc., of New York.

CHIEF ENGINEER
PRODUCTS TERMINALS AND PIPELINES

WANTED: Experienced engineer capable of establishing and supervising engineering department for construction of petroleum products terminals and products pipelines, including complete design, issuance of quotation requests and material authorisations, supervision of construction engineers and approval of subcontractors' designs. Must be able to provide preliminary design rapidly and estimate construction costs accurately enough to provide basis for competitive bids. Must have field experience in design and construction of terminals and pipeline including hydraulic, electrical, civil and mechanical design, and have mental capability of working for non-engineer. Will be located in Southwest. Some travel required. Will guarantee three years employment $20,000 year, if ability proven by performance. *Send resume including references to* **Box 210, The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.**



Let's keep our dreams big

A century ago a man dreamed of finding enough oil to light the lamps of the world. At the time, it appeared to be an ambitious dream, indeed, but it has been fulfilled more than a thousandfold.

Wanted for the next 100 years . . . more and bigger dreams from men with the vision and determination to make them come true.

STANDARD OIL COMPANY OF CALIFORNIA

NATIONAL® FILTERS

with National Shop-Fabricated Filter Manifolds

•

SAVE TIME • SAVE 25% OR MORE IN MONEY

National Filters have already proven their savings ability.

Filter manifolds fabricated from National Titeline® or PV® couplings and grooved fittings and valves are rigid and leak-proof. They afford a great degree of flexibility in assembly resulting in a minimum amount of time spent in field hook-up. If maintenance is ever required, downtime is at a minimum. Additional filters can be manifolded to existing manifolds.

Manifolds can be furnished in bare steel pipe or ceramic lined pipe, with manually or automatically operated valves and for gate valves or butterfly valves.

At purchaser's option, field welding can be completely eliminated. On your next filter installation, specify NATIONAL PACKAGED FILTER MANIFOLDS. All the above "Filters and Manifolds" can be shop skid mounted.

It's a National®

NATIONAL TANK COMPANY

DRAWER 1710

TULSA, OKLAHOMA

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THRU PRESSURE REGULATION ON CABOT AIR BALANCED PUMPING UNITS!

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★ **MORE CONSTANT COUNTER-BALANCE**—Giant Air Reservoir

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★ **REDUCED WEIGHT**—No Cast Iron Counterbalance

★ **REDUCED FOUNDATION COST**—Compact Design

★ **CLAMP TYPE HOLD-DOWN**—Easy to Install and Align

★ **PORTABLE BASE**—Optional Wide Base Unit for Test Wells

It's Easier to Handle Air than Iron Weights

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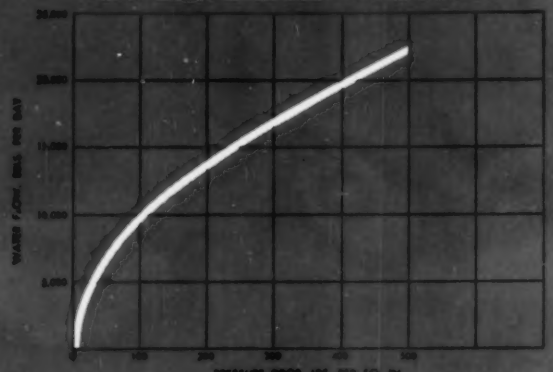
CABOT

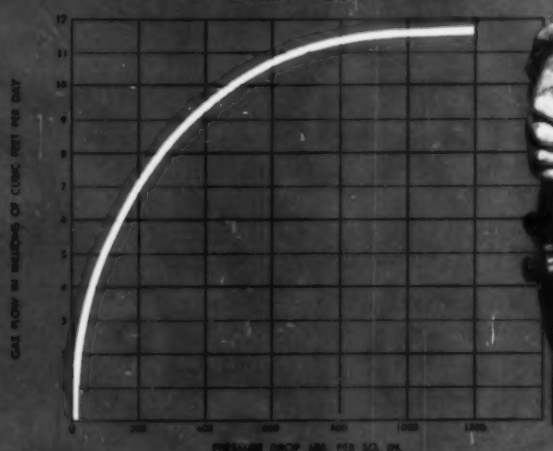
PAMPA, TEXAS

FRANKS DIVISION OF CABOT

Flow area thru UNIBOLT ADJUSTABLE WING VALVE
Passes Large Quantities of Fluid or Gas



FLOW OF WATER THROUGH UNIBOLT CHOKE WITH 1" SEAT



FLOW OF GAS THROUGH UNIBOLT CHOKE WITH ½" SEAT AT 2000 PSI INLET PRESSURE

if you could produce 10,000 bbls. per well per day . . .

. . . as the charts show, this UNIBOLT Adjustable Wing Valve would handle the fluid with only a 100-lb. pressure drop! Or, you could produce 28 million cubic feet of gas through it with only a 200-lb. pressure drop. So, while the UNIBOLT Adjustable Wing Valve is not a full-opening type, its one-inch flow area is far more than adequate for practically any desired production rate—*and the cost is importantly lower than for conventional gate and plug valves.*

Actually, there's a dozen more good reasons why this UNIBOLT Adjustable Wing Valve is a solid favorite among value-conscious operators:

1. There are no exposed threads . . . no accidental damage.
2. All metal seats . . . not affected by high or low temperature.
3. Stem packing that needs no tightening.
4. Stem turns freely under high pressures.
5. Threads on stem not exposed to external or internal damage.
6. Full 2½" pilot for true stem alignment and rigidity.
7. Streamlined flow—no obstruction, no turbulence or impingement of flow, no negative pressure areas.
8. Requires no grease to effect a seal . . . may also be used as micrometer-gauged flow bean.
9. Variable choke speeds up initial clean-up or running initial flow tests . . . saves rig time.
10. Can be converted to "Pressurematic Safety Valve" by simply changing bonnet assemblies.
11. Valve can be completely overhauled without removal from tree.
12. Stem seat sealed by metal gasket; power threads assure alignment.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

Of Things To Come . . . In Oil

SEARCHING FOR OIL BEYOND THREE-MILE LIMIT off the California Coast may be possible soon. Bureau of Land Management and state land office officials are in "discussion" phase of a cooperative agreement to permit oil exploration out into the Pacific. Of prime interest is area north of the Catalina Channel, whereby beaches could be protected, and to prevent interference with military defense activity.

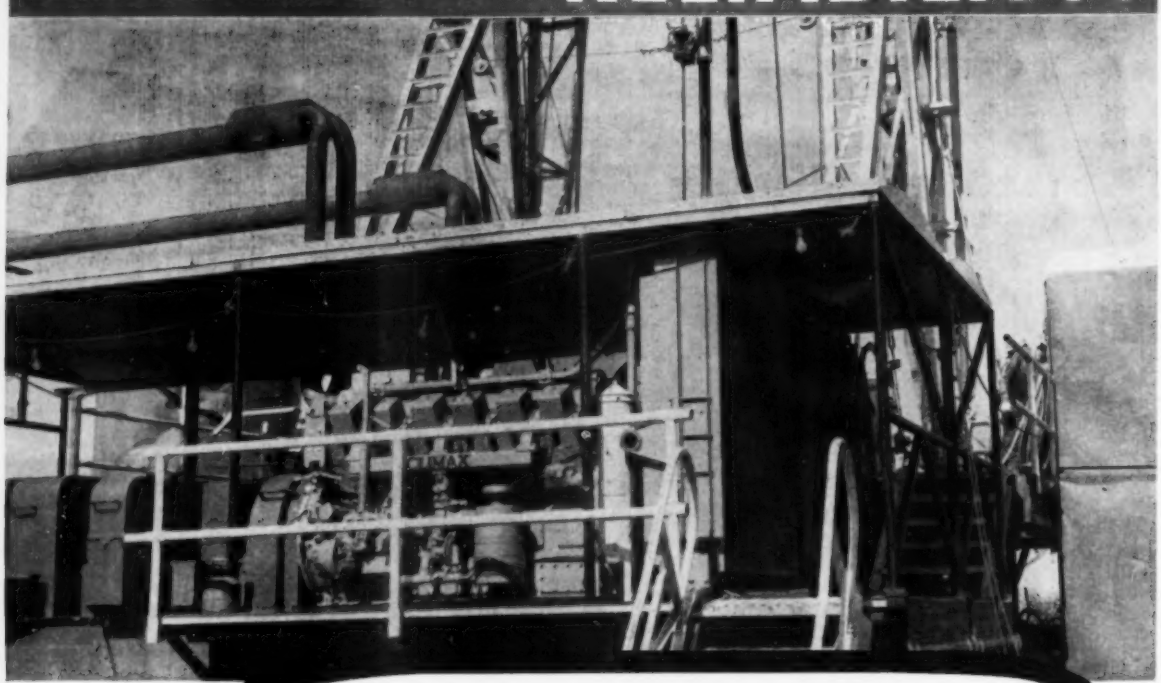
ALASKA'S OFFSHORE PROPERTIES will be open for competitive bidding to oil companies by September, says the 49ers' woman senator, Mrs. Irene Ryan. Acreage would be offered in 5700-acre blocks not yet selected. Of the 40,000,000 acres of offshore land in Alaska, probably about 3,000,000 in the Cooke Inlet area will be put on the block at this time. Several major companies recently completed a joint seismic study of the Cooke Inlet area.

PUBLIC HEARINGS ON PERCENTAGE DEPLETION will begin in Washington November 2. "Exploratory" hearings, conducted by House Ways and Means Committee, will be in form of panel discussions and will consider percentage depletion for oil and other extractive industries, and will include talks on exploration and development costs that are listed as business expense deductions. Do not expect any legislation this year.

WAGE DATA TO BE INCLUDED IN DRILLING BIDS? President of AAODC, Joe Zeppa has suggested such information should be included in bids for drilling contracts, and these facts weighed carefully by the operator before letting a contract. Such action, Zeppa pointed out to one oil company executive, may be necessary to halt "deterioration found in the quality of drilling crews" in certain areas. He also urged that fringe benefits as well as wage schedules be considered, pointing out higher operating costs will result from poor drilling performance caused by inadequately trained and inexperienced crewmen.

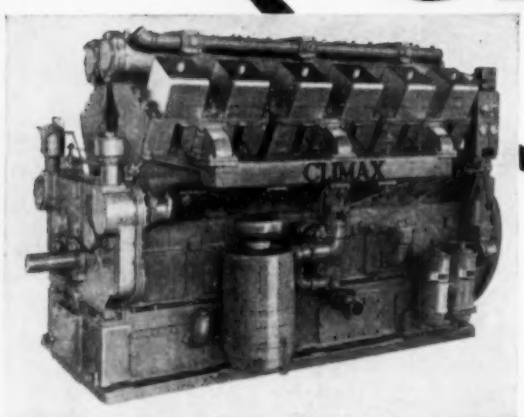
FEDERAL GOVERNMENT MAY FINANCE EXPLORATORY WELL that will probe unknown structure beneath the earth's crust. A well, planned to go to a record depth of 31,000 ft, is in "talking" stage. An unconfirmed report states that scientists will ask Congress for $15,000,000 to finance the exploratory wildcat.

where the PAY-OFF is on RELIABILITY!



Two Climax V-125's on a Cleveland County, Oklahoma rig.

CLIMAX OIL FIELD POWER



Climax Engines have proven their reliability in hundreds of oil field installations. Single, well balanced design, rugged construction, and quality materials make them smooth running . . . for years!

Model V-125
Max. hp 605 (Natural Gas)

CL-107

POWER UNIT PUMPING and DRILLING HP—CONTINUOUS DUTY

MODEL	Bore and Stroke	Displacement	Torque @ RPM	BRAKE HORSEPOWER AT SPEEDS INDICATED					
				600	700	800	900	1000	1100
R-110	6⅛ x 7	824	468 @ 800	52	62	71	79	86	91
R-165	6⅛ x 7	1238	684 @ 750	81	93	105	117	127	135
K-67	7 x 7	1616	955 @ 805	110	129	145	161	176	188
K-75	7½ x 7	1855	1090 @ 800	126	146	166	185	204	218
V-80	7 x 7	2155	1240 @ 850	140	165	188	210	230	246
V-85	7½ x 7	2474	1440 @ 900	164	194	223	246	266	284
V-122	7 x 7	3232	1915 @ 900	217	258	293	328	353	378
V-125	7½ x 7	3711	2220 @ 850	242	292	340	384	417	442

Write for descriptive literature

CLIMAX ENGINE MANUFACTURING CO. • DIVISION OF WAUKESHA MOTOR COMPANY
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FIBERTEX*

strong fibers *permit mud circulation without loss.*

FIBERTEX . . . bridges formation pores and blocks fractures to prevent or stop mud loss.

FIBERTEX . . . graded fiber sizes give quicker, more effective sealing.

FIBERTEX . . . mixes easily, works fast, resists decomposition. A little goes a long way.

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FULL VOLUME PENETRATION ...McCULLOUGH GLASS JET PERFORATORS

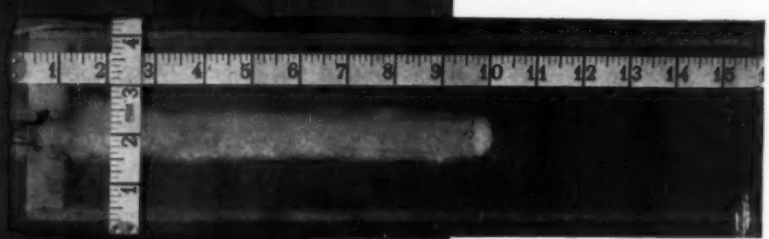
McCullough Glass Jet Perforators are powerful, hard shooting jet guns that give you penetration equal to or better than other jet processes.

They produce large, uniform entrance holes in the casing and large diameter, "full-volume" holes deep in the pay zone. More than this, McCullough Glass Jets do not form carrots or slugs that retard the flow of a full volume of oil.

McCullough Glass Jets offer you all the advantages of other jet perforating processes plus many additional benefits:

1. No carrots or slugs to plug holes.
2. Large, deep, "full-volume" perforations.
3. Efficient at all depths and under excessive pressures and temperatures.
4. Versatile Steel Strip Carrier – will flex its way through crooked hole – allows use of larger, more powerful jet charges yet is safe in the well – run any length desired (up to 150' firing 600 shots) to perforate a single zone or multiple zones in a single run – steel strip is removed from well on the wire line after firing.
5. Almost 100% junk free in all respects.

Berea Sandstone target perforated by McCullough Super Casing Glass Jet. In supervised tests these jets obtained an average penetration of 9.208". Hole size in Berea Sandstone target averaged .850".



McCullough TOOL COMPANY

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SIZES AND TYPES – (For 4" OD casing and larger and open hole).

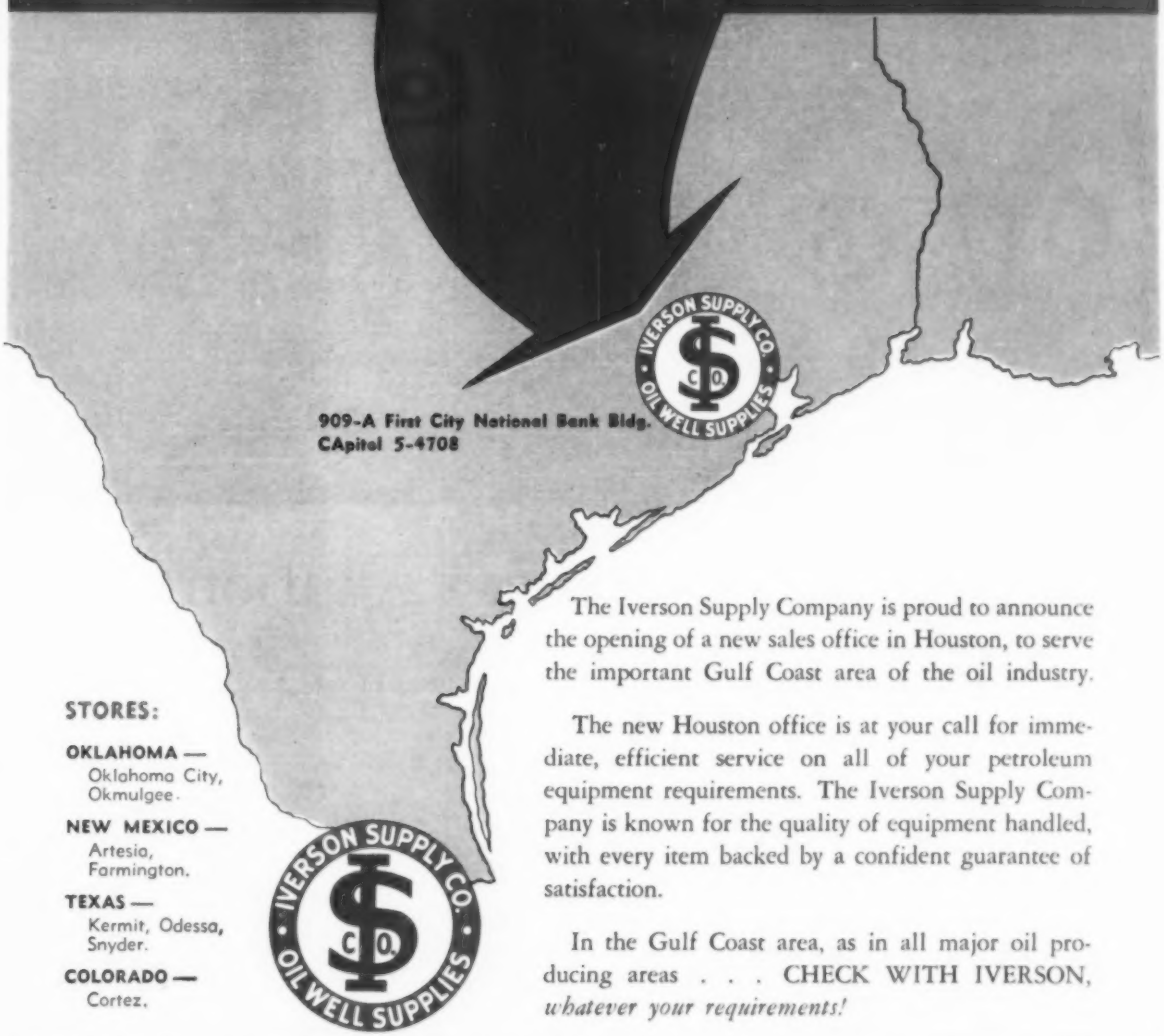
STANDARD CASING GLASS JET – 3½" and 3¾" OD – 1, 2, 3, 4 or 6 holes per foot.

SUPER CASING GLASS JET – 4" and 5¼" OD – 1, 2, 3 or 4 holes per foot.

SUPER FORMATION GLASS JET – 4¾" OD – 1, 2 or 3 holes per foot.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

a NEW sales office for IVERSON SUPPLY . . . in HOUSTON



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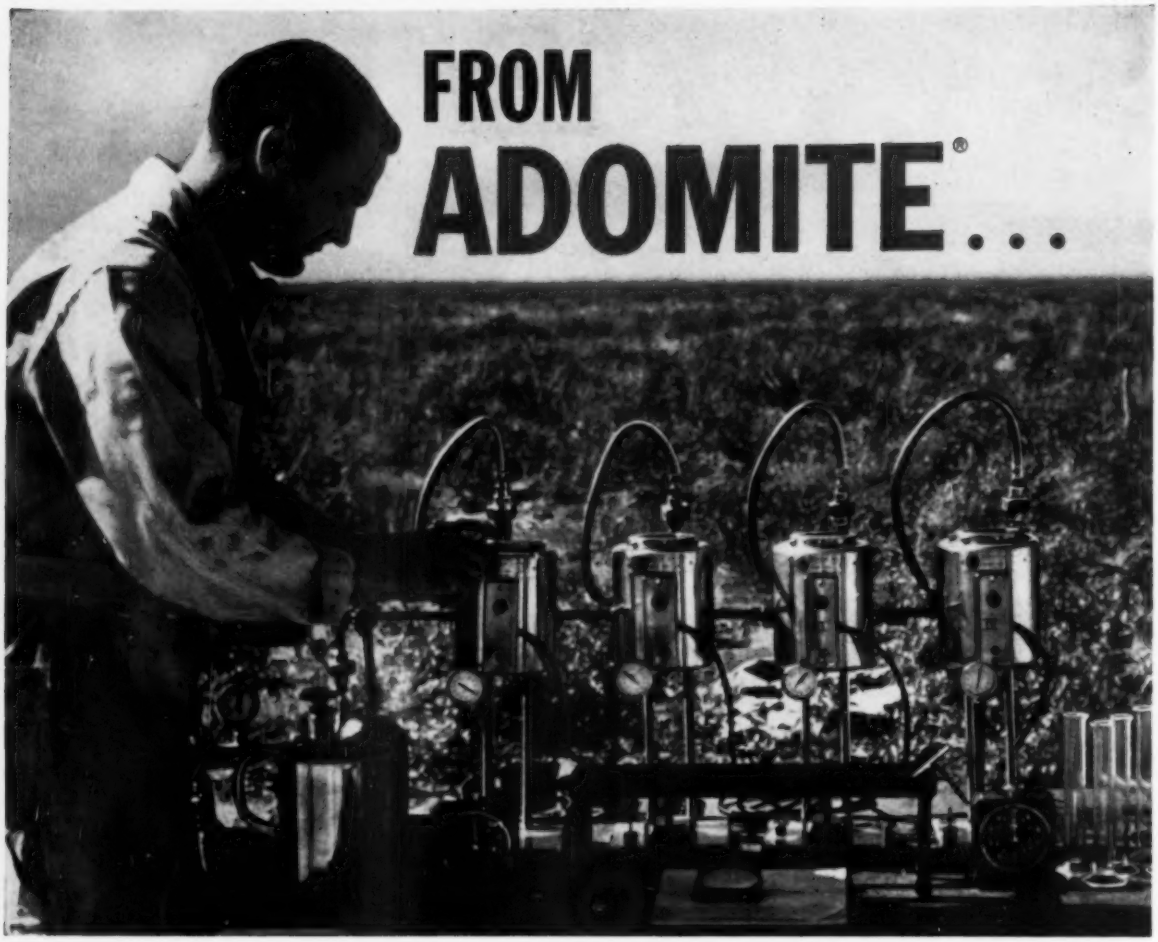

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The tools you see here are representative of the complete line available at Homco — the most complete line of Directional Drilling tools in the industry.

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STRAIGHTENING
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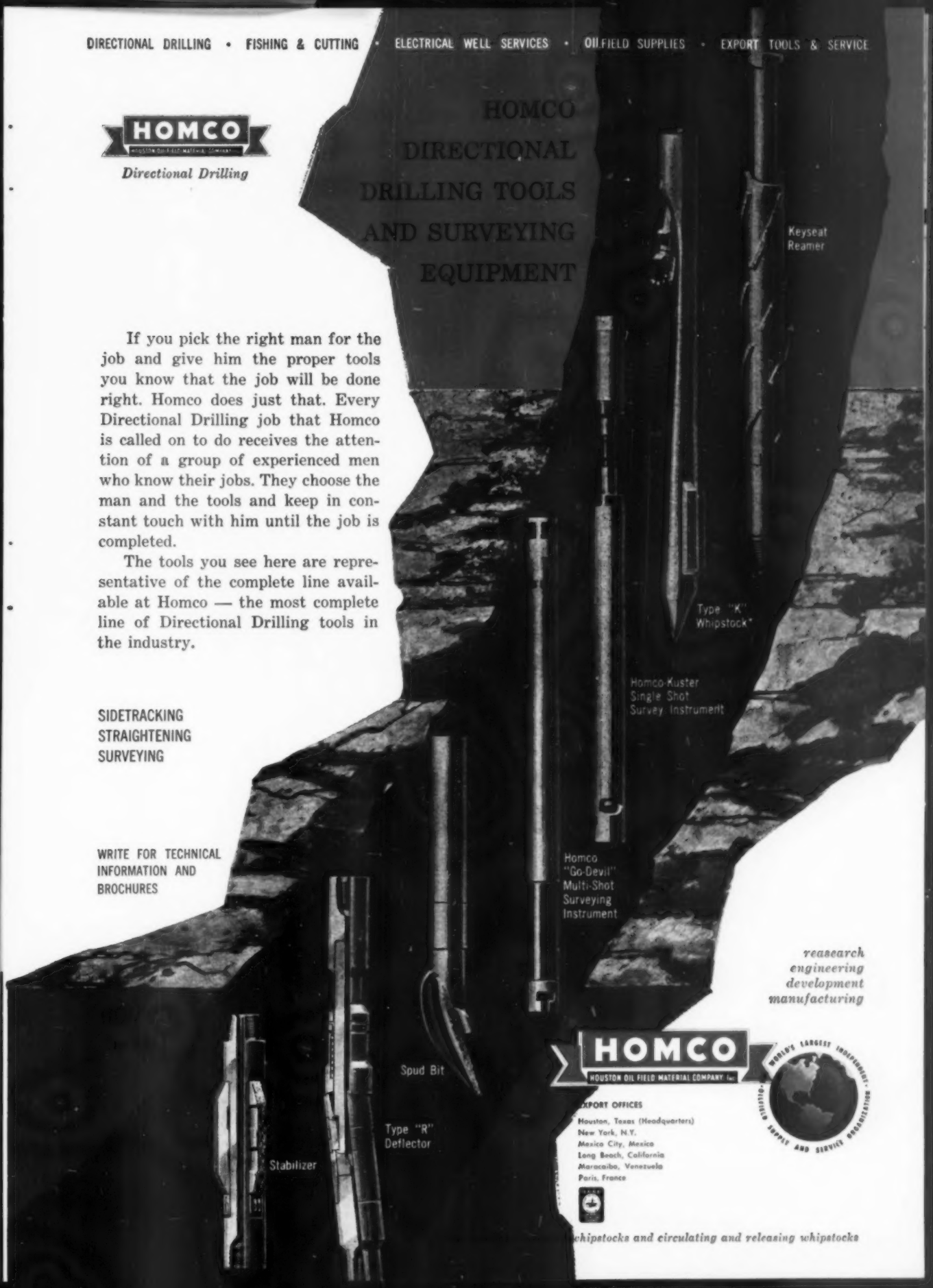

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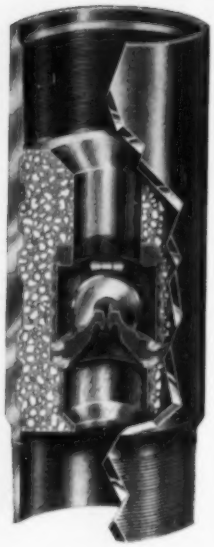
whipstocks and circulating and releasing whipstocks

THE PERFECT COMBINATION

For Protecting Low Pressure Producing Zones

A LARKIN FILRITE FLOAT COLLAR
A LARKIN CEMENTROL GUIDE SHOE



Filrite Float Collar
Fig. 451

FILRITE EQUIPMENT was designed to allow automatic filling of the casing while it is being run and to eliminate pressure surges which might break down weaker formations.

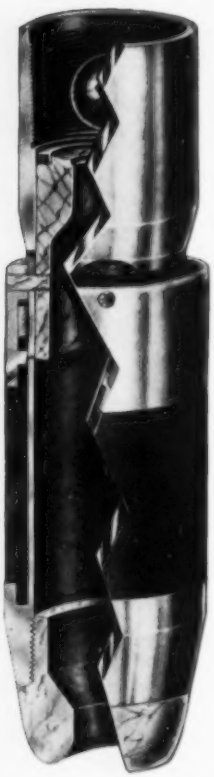
CEMENTROL EQUIPMENT was originated by Larkin for the purpose of protecting exposed producing formations against contamination by cement. Cementrol effectiveness has been proved in thousands upon thousands of wells over a period of fifteen years.

In combination, Filrite and Cementrol Equipment will provide maximum protection when casing is cemented above a producing zone.

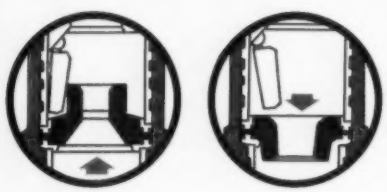
Filrite Equipment contains a resilient diaphragm valve which prevents entrance of well fluid into the casing until several joints have been run. When fluid pressure from below overcomes the inherent resistance of the valve to open, the valve then opens and allows partial fill of the casing without overflow. This type of fill-up is continuous until casing is landed.

The Cementrol Guide Shoe serves as a guide until casing is landed. A bridging ball is then dropped and by pump pressure from the surface the Cementrol packing element is expanded against the wall of the hole and no cement can contact the producing zone.

For additional details on Filrite and Cementrol please refer to your Larkin catalog—or call your nearby Larkin representative.



Cementrol Guide Shoe
Fig. 227

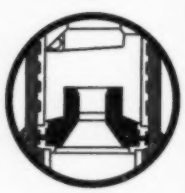


A

Circle A, a view 90° from that of the large illustration, shows the Filrite valve in running-in position. The resilient diaphragm valve remains closed until the differential fluid pressure across it overcomes its inherent resistance to open.

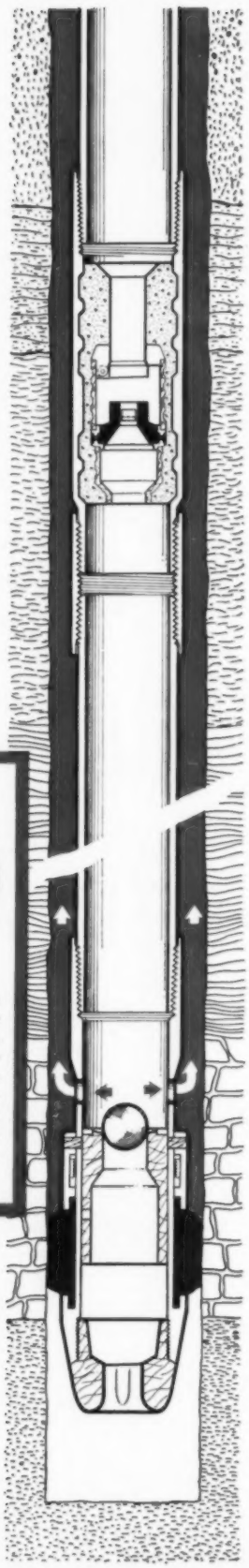
B

Circle B shows the rubber diaphragm inverted by pump pressure as the well is being cemented. Filrite is full opening and will allow passage of a bridging ball to actuate other equipment which might be installed on the casing beneath a Filrite Collar.



C

Circle C shows the spring-loaded flapper valve in closed position after being released by inversion of the diaphragm. The flapper valve in the Larkin Filrite equipment is very strong and has no depth limitations.



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MARTIN RUBBER GUIDE CAGES BY

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Metallic back-stop is now available in Closed Type Cages by use of 18-8 insert in upper part of rubber guide. Ball never touches this metal in normal pumping.

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The Martin Rubber Guide Idea, which has proven successful beyond anyone's expectation, is now available in improved form. The primary rubber ball stop for normal operation is now backed up by a metal stop to take the unusual ball impact which sometimes occurs.

Easily replaceable, mechanically held rubber guides often permit the renewal of cage life several times. They outlast metal by a great margin and usually increase ball and seat life two or more times.

Many production men specify MARTIN CAGES in all their pumps. Our cages are available in all sizes and types to take care of anyone's requirements.

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America's super-quality line—with a 35 year record of keeping performance *up* and costs *down!* Five types—to fit practically any service condition. All assembled, adjusted, lubricated and *sealed* at the factory for precision performance—long life—dependability.

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- Designed for extreme precision and high load capacities.
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Guiberson
Casing Swab
with "GW" Cups

FLEXIBILITY

that means every-drop casing swabbing!

GUIBERSON "GW" CUPS

**hug casing wall—
automatic seal,
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- Unequalled in rough or mixed casing strings
- Stout, flexible lip brings up every drop
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- Abrasion resistant compound — takes up own wear
- Performs better — lasts longer — costs no more
- Interchangeable on the Guiberson Casing Swab

Guiberson Swab with "GW"
and "K" cups offers greatest
size range on the market.

Better Be Safe Than Sorry!

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another
TRETOLITE SERVICE
report

STOP LOSING OIL DOLLARS!

start treating with TRETOLITE chemicals

TRET-O-LITE* *Demulsifiers*

TRET-O-LITE Demulsifying Chemicals separate a water phase from an oil phase, or vice versa.

Separation procedure consists of injecting and dispersing a small proportion of the proper TRET-O-LITE Demulsifier with the emulsified fluids, then providing suitable storage where oil and water can separate. Because of the large number of problems encountered in treating petroleum emulsions, a large number of chemical demulsifiers have been developed.

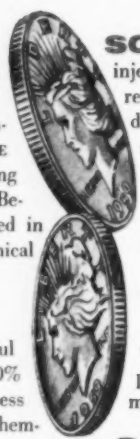
TRET-O-LITE* *Chemical Desalting*

TRET-O-LITE Chemical Desalting removes harmful salts from crude oils, and does so in the 95% to 100% efficiency range. It is currently being used to process over 1½ million barrels of crude daily at an average chemical cost of 1.3 mills per barrel.

The Tretolite Company offers a choice of installation plans: Tretolite desalting equipment may be purchased, rented, rented with option to purchase, or constructed by the refiner according to Tretolite design and specifications.

KONTOL* *Corrosion Inhibitors*

These liquid organic semi-polar compounds are available in various formulas, which adsorb on metal surfaces to form an impervious film that inhibits corrosion. This film protects the equipment from corrosive elements in either brine, crude oil, gas or combinations of these. The strength of the bond between the protecting KONTOL film and the metal surface is demonstrated by the fact that protection continues for a substantial period after treatment is stopped.



SOLVO* *Paraffin Removers*

SOLVO can be injected into oil wells, pipelines, or storage facilities to remove and prevent the accumulation of paraffin. Such deposits often cause sucker rods to stick, requiring shutdown for removal. They also clog lead lines to the point where fluid throughput is seriously reduced. Paraffin settlings rob storage tanks of valuable capacity. SOLVO is useful in removing and preventing such accumulations.

FLUDEX* *Water Flood Additives*

FLUDEX is applicable to the stimulation of injectivity in water flood and water disposal systems. It acts also to prevent corrosion and scale deposition, and to assist in maintaining and restoring the permeability of formations.

S. P. *Scale Preventives*

S. P. Scale Preventives are used in producing wells to prevent the deposition of calcium hardness scales. They prevent damage caused by deposition of scale in oil well tubing, sucker rods, well casing, flow lines, heaters and water-disposal or water-flood systems.

TOLAD† *Fuel Additives*

TOLAD Fuel Additives are ashless, totally oil-soluble compounds designed to enhance the stability of domestic heating oils and diesel fuels, as expressed in color and residue. These additives have excellent water tolerance characteristics in reducing sludge formation and loss to water bottoms in fuel storage. They are available in inhibitor or inhibitor-dispersant formulas.

*TRET-O-LITE, KONTOL, SOLVO *and* FLUDEX *are registered trademarks of Petrolite Corporation.*

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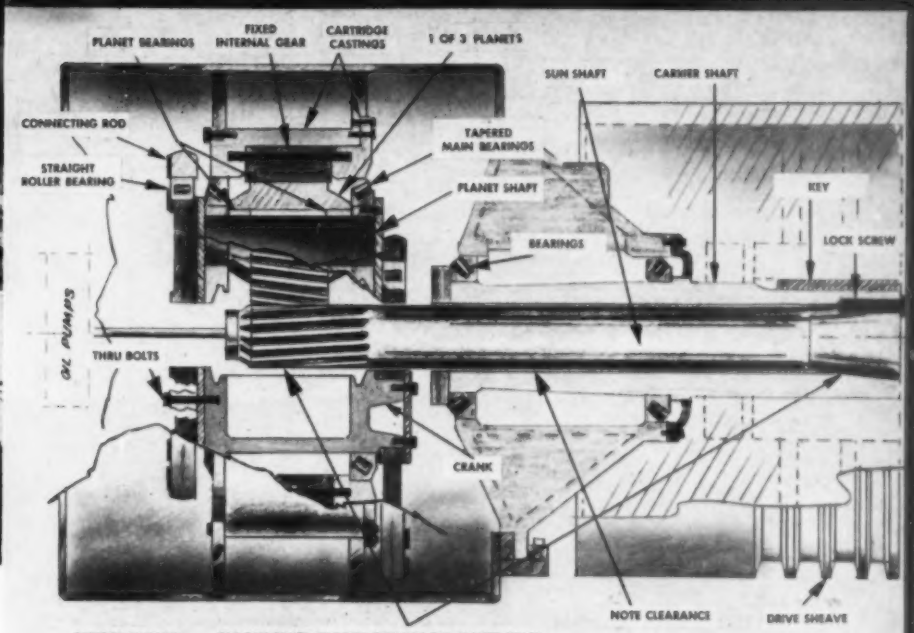
A series of 8,000 to 10,000 feet wells in Gulf Coast and Southwest Texas show improved penetration and savings in bits.



Consider these EXCLUSIVE ADVANTAGES OF THE WHELAND HP-16000 SLUSH PUMP

WHELAND DUPLEX POWER SLUSH PUMP, 7¾" x 16", 600 HP at 65 RPM

U. S. Patent 2,649,988 and 2,717,186. Other patents pending.

Planetary Gears

Compact. All working parts contained BETWEEN the piston centers. The gear cartridge assembly easily accommodates big bearings for added life. All pumping loads carried through connecting rods to the power end are contained within the circles of the gear cartridge. Eliminates parts subject to deflection and fatigue type loads, and maintains alignment of connecting rods and bearings.

Cylindrical Crossheads

Piston-like cylindrical crossheads operating in honed cylinders are engineered to give permanent perfect alignment in every direction.

Floating Input Shaft

The sun or input shaft floats between the mesh of the three planet gears and the tapered seat in the carrier shaft for even distribution of the load. All loads from the pull of the belts and weight of sheave are carried into the steel housing independent of the sun shaft. Hence, the sun shaft transmits only the torque load to drive the pump.

Small Sheave

6.8 to 1 gear reduction permits small sheave. Note overhanging flange turned toward the pump. Pump may be driven from either side.

WHELAND

ROTARY DRILLING MACHINERY

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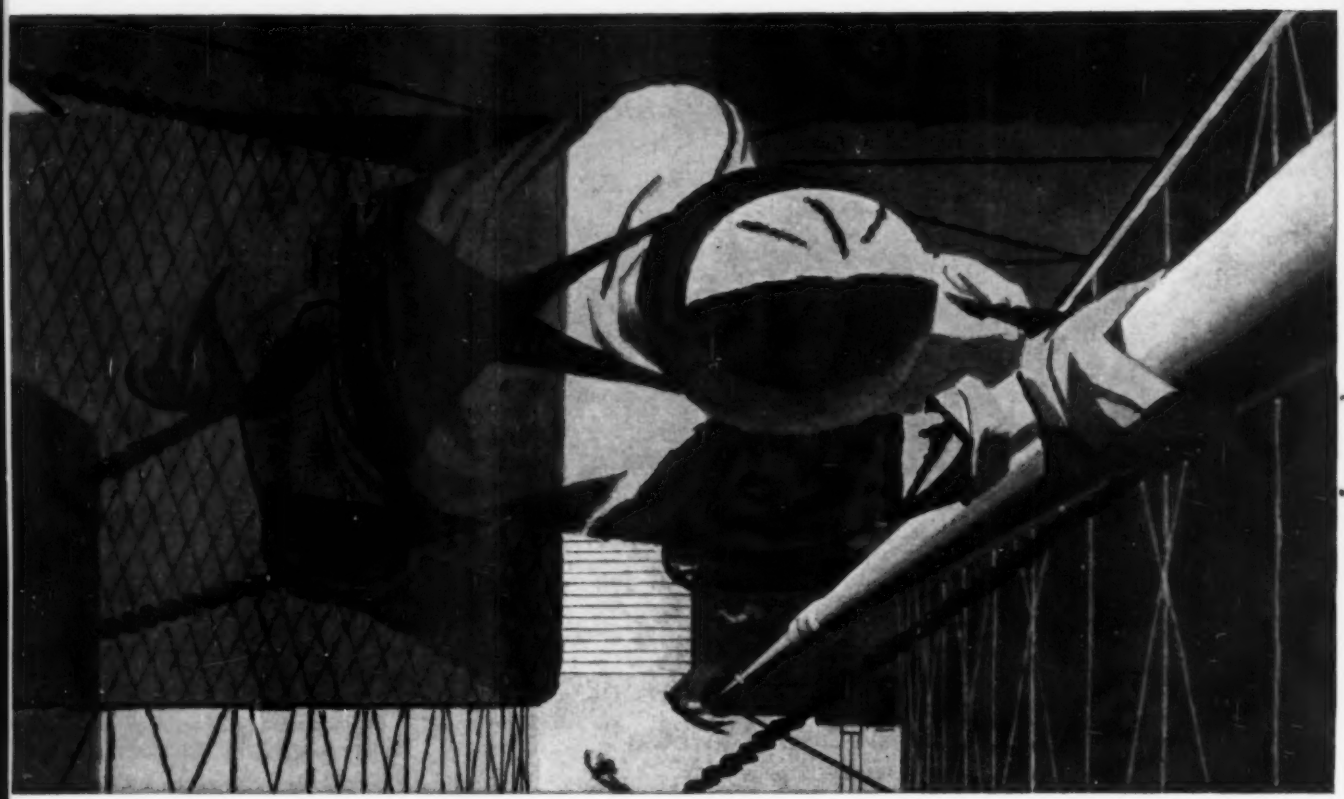

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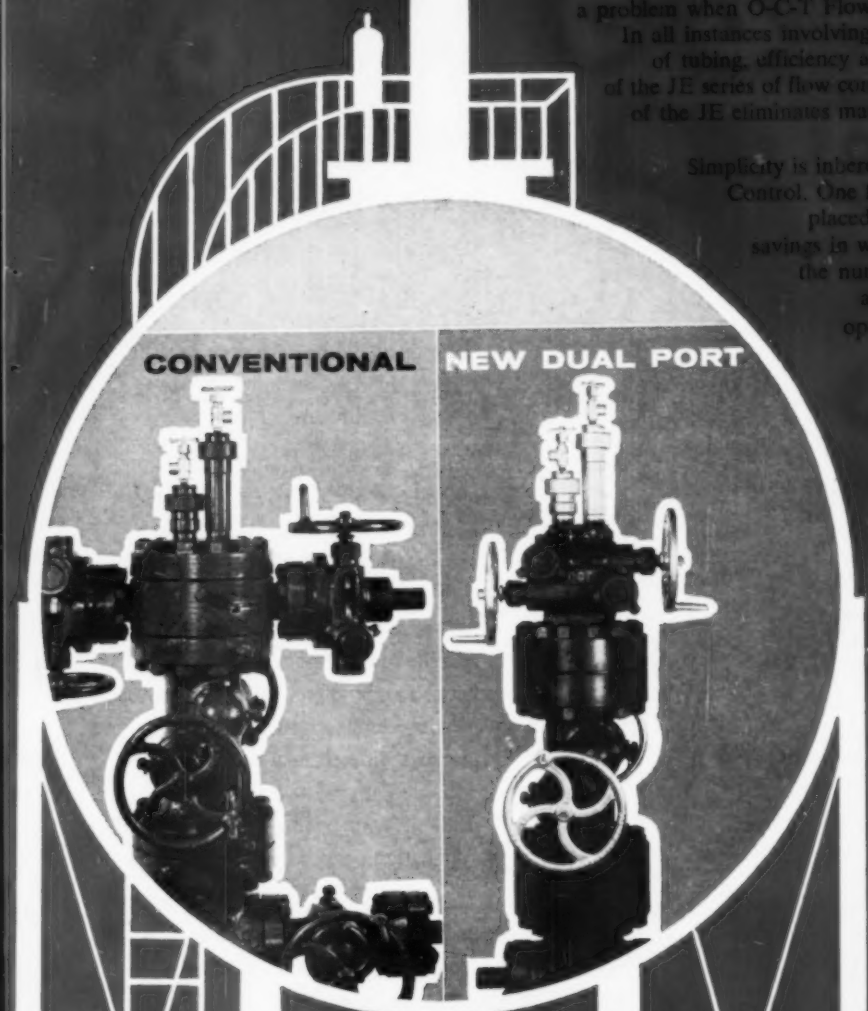

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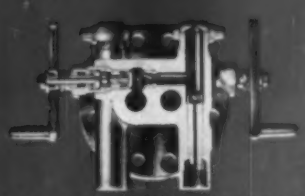

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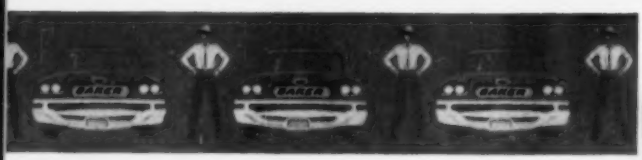

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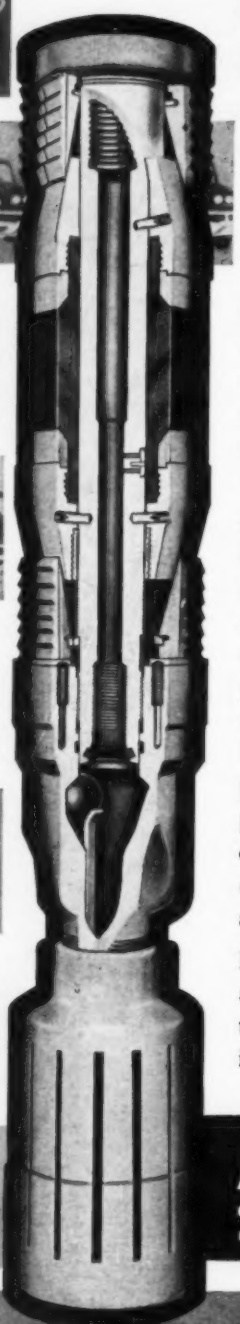

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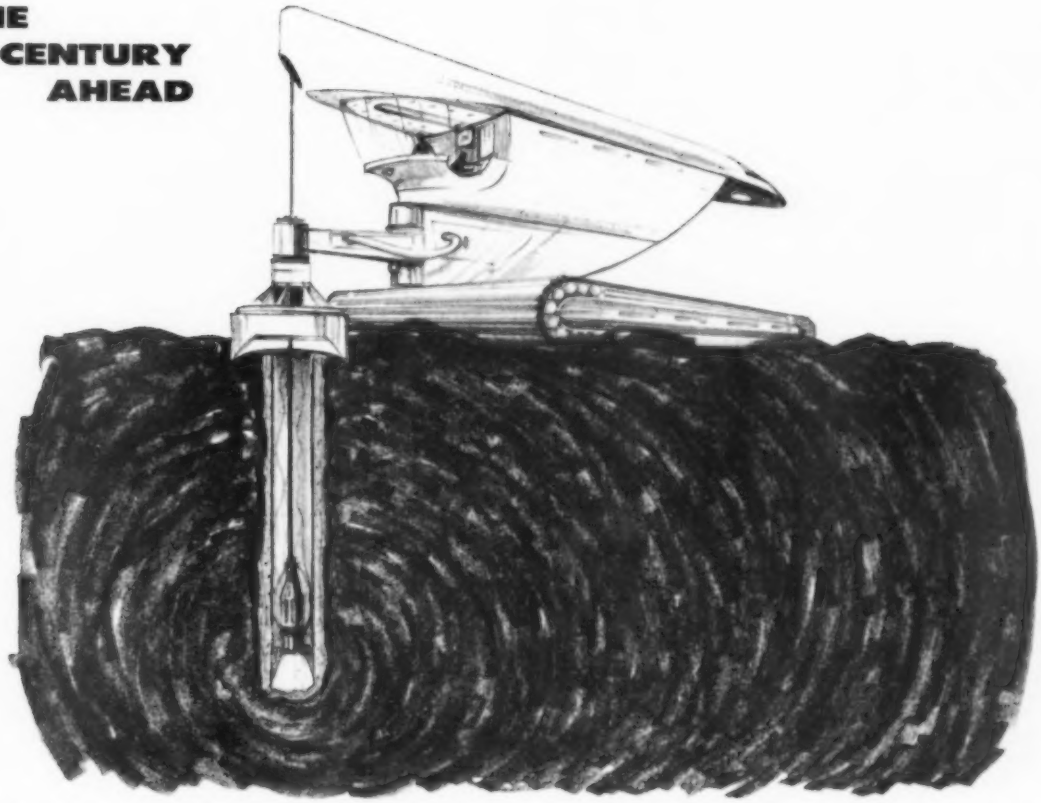
THE CENTURY AHEAD



Flame jet drilling now under investigation uses a newly developed liquid rocket fuel (or possibly nuclear fuel source). It could burn a hole in the ground leaving a ceramic-like sheath serving as casing. The jet flame assembly would be suspended from high strength flexible tubing which would supply fuel for the jet flame. The jet assembly would be guided by strong gyros and combustion gases would be analyzed continuously for formation data. The unit would be highly mobile and operated by only two technicans who would live in air conditioned quarters within the machine.

THE CHANGING SCENE . . .

In Drilling and Producing

Technological developments continue at a rapid pace and the future will see even faster development of new tools and techniques. New developments are being hastened by the tightening and downward descent of profits in oil and gas operations everywhere. Take this quick look into how future oil and gas may one day be developed and produced . . . it may stimulate your thinking about the future of our petroleum industry

Gilbert H. Tausch
Director of Engineering
CAMCO, INC.

MUCH OF THE HAZE WHICH CLOUDS THE FUTURE picture of drilling and producing operations can be cleared by a composite look at what's happening in today's fast-moving technology. Drilling to 50,000 ft now is not as absurd as a 10,000-ft well was 25 years ago. Depth at which liquid hydrocarbons are found and produced to the surface continues to increase year by year . . . and it wasn't many years ago when it was predicted that none would or could exist below 20,000 ft. And, the idea of producing subsurface liquids through extremely small diameter tubes was also ridiculed. Even after the last world conflict, it was considered unreasonable to expect to recover more than 30 or 40 percent of the oil originally discovered. Many waterflood operations of today use these figures as minimums . . . and many exceed 60 percent. New processes in operation go over this figure . . . and laboratory research indicates upward of 90 percent recoveries!

Recognizing that technology has accomplished so much in the last decade, it is conceivable that at least as much

THE CENTURY AHEAD

. . . and perhaps more . . . will be accomplished in the next quarter century. And, beyond that . . . if technology continues . . . an entire new and perhaps "space-age" appearance will take over what we know as the petroleum industry.

One important note before we explore future possibilities in the way of equipment and techniques: Economics! This one word has done more than any other factor to accelerate current developments. For, we are still operating in a free economy where costs and profits are important to the individual company. What are the economic factors causing so much acceleration of new techniques and operations?

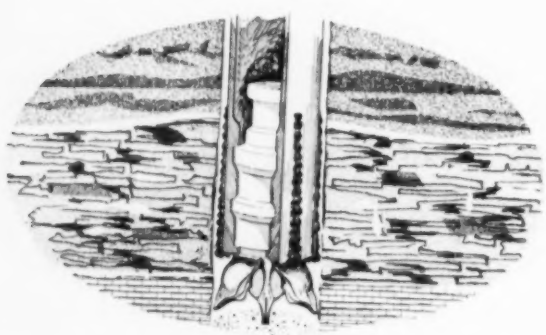
ECONOMICS: DRIVING FORCE BEHIND TECHNOLOGY

Worldwide oil producing capacity exceeds demand. Although the yearly demand for oil has increased both domestically and internationally, the daily oil production per well has not increased in the United States and some foreign areas. Rising costs of labor and materials have increased at a faster rate than any minor oil price increase due to the inability to increase oil prices in the face of ever-growing oil producing capacity. The domestic oil producer, particularly, has been trapped in the inflationary spiral and the return on investment for the oil industry has been steadily decreasing in the face of prosperity. *This rate of return is now comparable to other manufacturing concerns although investment risks in the oil industry far exceed those within other industries.*

Technological advances during the last 10 years have been impressive and have assisted oil companies in combating inflation. However, a more radical departure from present-day techniques must take place if profits are to be maintained or rightly increased, in view of the necessary deeper drilling, lower discovery rate and smaller reserves discovered.

LOOKING AHEAD IN DRILLING

In the field of drilling, some experimentation has proceeded along radical lines. Some of these exotic processes use flame or jet drilling, vibratory drilling, sonic, electrical arc, percussion and the well-known mud-driven turbine drilling. Some of these processes utilize present drilling rigs as well as conventional drill pipe and mud pumps; while other processes utilize cables, generators or chemicals. When discussing cost cutting methods in the drilling industry it is impossible to disregard the tremendous investment in drilling rigs and equipment now owned by drilling contractors and oil companies. Any new drilling technique must provide adequate and economical penetration of the earth at costs that ignore the initial investment or depreciation of drilling rigs if the technique is to be universally accepted in any short period of time.



Retractable wire line bit seated at bottom of drill casing. Future developments might combine the two (casing and bit) so that casing equipped with a cutting section on bottom could drill through softer surface formations. When harder rocks were encountered, a wire line bit could be run and seated in a landing section on bottom. Upon reaching the final T. D. casing would then be cemented in place.

The Technological Attack on Costs

When analyzing the cost of drilling new wells, it must be remembered that bit rotation and trip time generally consume at least 50 percent of the time necessary to drill a well, although they usually do not constitute one half the cost of a well. Casing or tubular goods utilized in the final well setting constitute 30 to 60 percent of the final well cost, depending upon area, depth, hole size and other conditions.

Greatest cost reduction in drilling operations, therefore, may result from a large reduction in the tonnage of tubular goods and a reduction of trip time necessary to change bits.

Retractable Drill Bits

Some work has progressed on retrievable blade and roller bits that can be run through drill pipe or casing on a wire line and can be retracted when dull. Many oil industry personnel have desired a drill bit that is capable of drilling the entire well without removal. These ideas are compatible.

Surface casing might be run with hard surfaced teeth on the lower joint and with a retrievable center section bit, such that the center section is removed and replaced by a wire line when dull. The hard surfaced teeth on the bottom joint of the surface casing can be of such length and magnitude as to complete the drilled hole to total depth.

It is conceivable that this center section may be replaced by, or be made in conjunction with, a continuous logging device that records the necessary information on multichannel tape recorders and permits the log to be analyzed at the well site while cement is setting.

The same technique, with much smaller oil string, may use this arrangement to drill additional hole below the surface casing. In this method, the tubular goods used for casing serves as drill pipe until set as casing. A chemical might then be added to the drilling mud, when total depth is obtained for each casing string, and the drilling mud remaining in the annulus between the casing and well bore will then harden like cement as a result of the chemical additive. Those field personnel who have attempted to remove drilling mud from the annulus surrounding well tubing may feel that this latter development has already been achieved.

Air and Gas Drilling

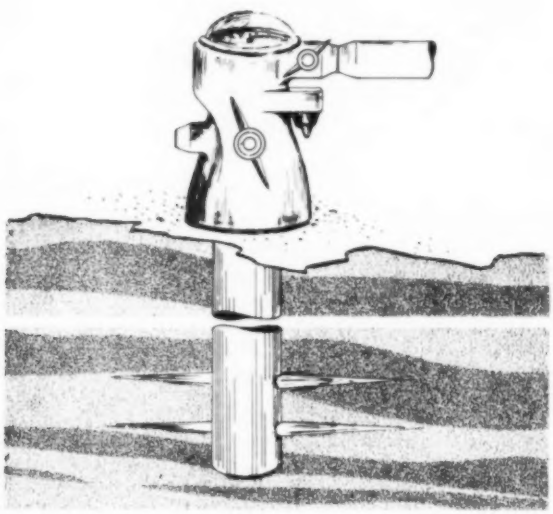
Phenomenal drilling rates and lower cost obtained by air and gas drilling cannot be ignored. Recent advances in de-watering materials have extended the use of air drilling to a limited extent. Higher-pressure air drilling is feasible utilizing jet engines to produce gases with much higher pressure by burning petroleum fuels and eliminating air compressors. As it becomes possible to utilize casing as drill pipe and to eliminate trips to repair dull bits, air drilling and conventional drilling under surface pressure

become very attractive. Elimination of overburden on the formation by a drilling mud column can permit continuous sampling of the formation and a different arrangement of rock stresses that permit much faster drilling rates.

Smaller Bore Holes

Excessive cost and size of tonnage used in present oil and gas wells dictates the eventual move to small diameter drill pipe and casing as well as to smaller tubing or the elimination of tubing. The present trend by some operators to 2⅞-in. tubing as casing, and the elimination of well flow tubing, may become industry-wide since it is obvious that it is not necessary to complete a well in such a manner as to permit it to produce 5000 to 15,000 bbl per day, at least in the U. S.

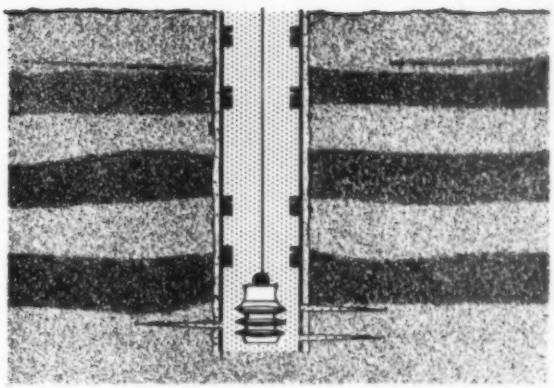
A recent completion by one operator of several strings of tubing cemented in open hole to 12,000 ft in depth as multiple tubingless completions, demonstrates the feasibility of these operations. Although many operators have made multiple completions within a single casing string at enormous savings, the possibility of drilling to total depth without removing pipe, and at much faster rates because of the elimination of drilling fluid overburden and continuous sampling and recording of earth formations, may well make it more economical to complete single wells in the future or convert to the necessary weight drilling fluid as total depth is reached, and cement numerous small tubing strings in a common bore hole.



Compact unitized well head will be smaller, simplier in the future. Indicators on the surface assembly would provide visual data on well performance . . . perhaps total flow for a given period. Tubingless completions would simplify multiple and single completion units.

PROGRESS IN COMPLETION PRACTICES

Industry acceptance of small diameter through-tubing perforators has already made practical the perforating of casing after the drilling rig has been removed from the well location. Radioactive logging is now practical using tape recorders to record the necessary subsurface information which may be transmitted to strip charts at the surface. It is also possible at this time to run through-tubing perforators on a piano wire line, thus eliminating large conductor line trucks.



Small-casing, tubingless completion will make it practical to use consolidating materials as a perforating fluid. Injection of the material is permitted into the formation immediately upon perforating if a pressure differential is maintained into the formation.

In Perforating

The future will undoubtedly see perforators that are dropped into the well, activated at the proper location, and the gun mechanism then flowed back to the surface as the well is produced. In areas of excessive sand production, it has already been suggested that a consolidating plastic be placed in the casing opposite the interval to be perforated, while cementing material is placed around the oil string, and that perforating guns be fired in the consolidating material which is then flushed into the formation, consolidating the sand grains as a porous filter. The plastic may be caused to set by the natural chemicals contained within the sand or by catalysts carried into the well by the gun mechanism.

This type of tools as described for completion operations would be simple and easy to utilize without large surface equipment and should be available in the near future.

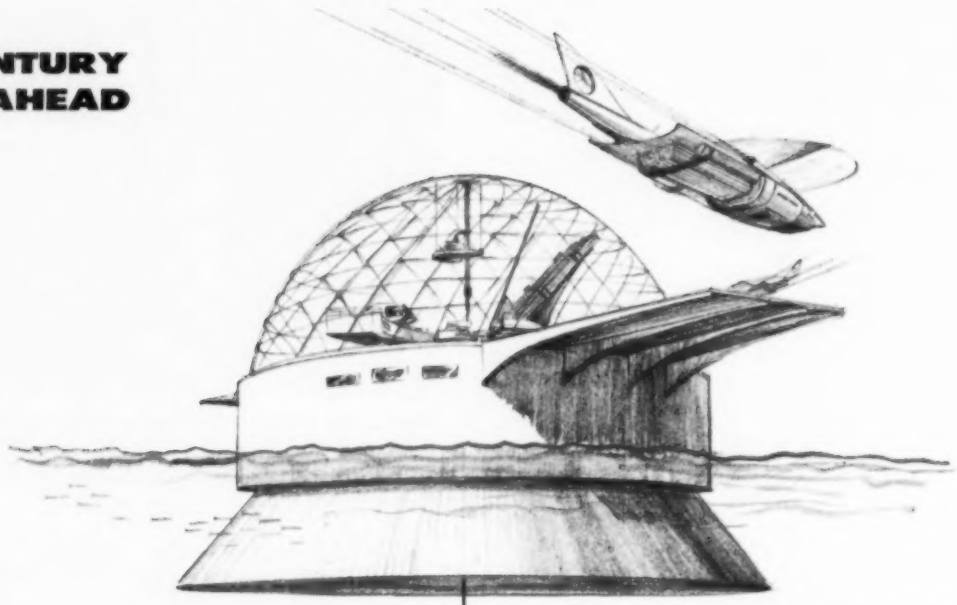
Reworking Operations in the Future

Reworking oil and gas wells equipped with either large or small diameter tubular goods is already possible with small wire lines or with small rigs. As cost reduction continues, more and more well service will be handled on a consolidated basis. A diagnostic service will be available in the future that incorporates instruments which are run on a small piano wire line or dropped into the well and flowed or circulated out. This type of service will become available much sooner for tubingless completed wells with 2⅞-in. pipe as casing.

When a complete diagnosis of the well's conditions are available, a second miniature unit will then rework the well. Cementing material may be pumped in place opposite perforations, the excess removed and the remaining cement set by an explosive charge or second fluid.

It will also be possible in the small diameter wells of the future to squeeze cementing material into the isolated portions of the perforated interval by a tool lowered into the well by wire line or to mechanically isolate a water or gas producing interval when the cementing material surrounding the casing has not been fractured.

When diagnostic and well workover services become consolidated, they may then be obtained on a contract



Ultra-deep water drilling barge has structural plastic dome and expanding skirt below the water line to act as a stabilizer. Jet powered helicopters transport all supplies and men to barge.

basis for numerous wells or on a retainer basis for continuous service. In most instances, they will be dove-tailed with a reservoir analysis service that will permit continuous appraisal of well conditions and well repair for the entire field with uniformity between operators. The ability to obtain almost 100 percent oil recovery from reservoirs by secondary recovery will permit an overall optimized field operating program that allows existing closely spaced wells to be abandoned or by-passed to reduce the quantity of operating wells and the necessary number of workovers.

OFFSHORE OPERATIONS OF TOMORROW

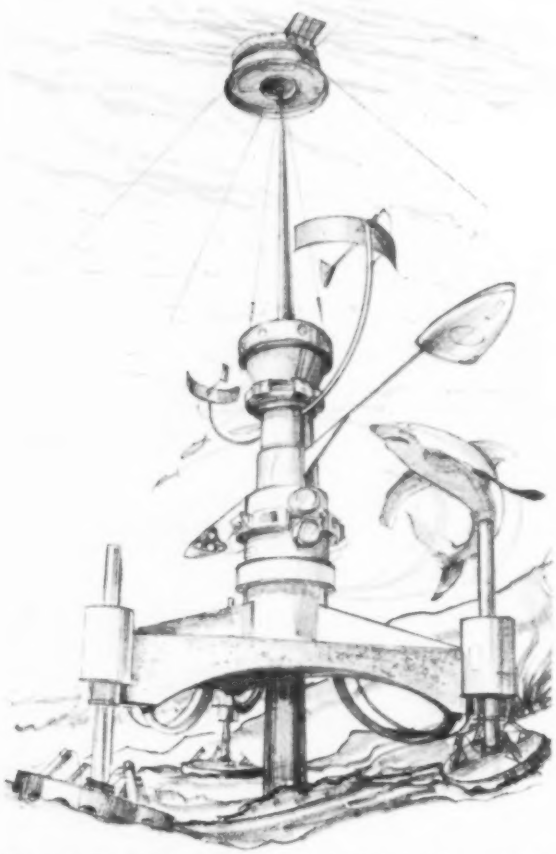
As discovery and development operations in the still largely unexplored offshore area increase, future drilling, completion and producing operations utilized on land will again be used in water locations. Floating rigs are already available and have been successfully used on many test wells. The trend to smaller tubular goods will permit placing the wellhead on the ocean floor in the position now occupied by blowout preventers during drilling operations. Elimination of platforms during drilling or producing operations permits completions in much deeper water and more economical completions in all depths of water.

In the case of oil production from offshore wells, flow of oil will go directly into tankers or floating tank barges instead of initially producing oil through pipelines to shore. In areas that permit such operation, the present mode of LPG storage will be used for the storage of oil using ocean water to empty the caverns and force oil into loading surface or submarine tankers.

Marine Workovers

Reworking operations are feasible even today from floating barges and the use of miniature equipment run on wire line, or pumped into and out of wells, will make possible reworking operations from small barges that are permitted considerable vertical and lateral movement on the ocean surface.

The present technique of lowering blowout preventers down guide lines for subsurface installations can be utilized to lower lubricators and flexible conduits from the sub-



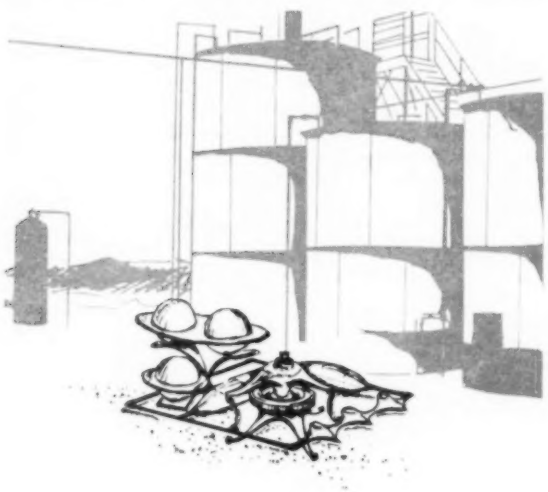
Ocean-bottom hookup for deep sea drilling might incorporate a stabilizing pod equipped with blowout equipment, continuously monitored from the surface by directional television cameras. Drill pipe is centered and held in position by an auxiliary magnetic field. Pipe is guided in and out of pod by the same magnetic field.

THE CENTURY AHEAD

surface wellhead to a floating barge. Use of divers, diving bells and underwater television will be used when necessary.

DEVELOPMENTS AHEAD IN PRODUCING OPERATIONS

Lease automatic custody transfer is now in common use and extremely small skid-mounted units that contain oil, gas and water separators and meters are now being tested and have been described in other articles. Wells of the future will have well automatic custody transfer. Fluids will be separated at the wellhead and a transmitter will monitor production data to the local office where such data will be stored in a computer installation. Production data will then be printed for local production personnel



Compact automatic custody transfer unit, measuring 4 × 7 ft, will have all built-in facilities for oil, water and gas separation. Silhouetted in the background is a conventional battery now required for the same function as future streamlined unit will handle.

and transmitted to a general location where market demand, refinery capacity and pipeline capacity data are also gathered. All operations may then be optimized and well production will be matched to market demand and oil refining capacity will be prepared for changing demands or changing crude oil supply. A computer program at the field office will then set well production to dove-tail with the optimized overall program and will notify the main computer office of failure to deliver production due to well conditions or reservoir conditions.

Lifting Fluids in the Future

Artificial lift presently supplements reservoir energy but is sometimes costly because of failure to tailor installations to actual needs or due to changing well conditions. Installation costs in the future will be reduced by a more thorough knowledge of lift demands and equipment performance and these installations will be tailored to secondary recovery operations and pressure maintenance operations.

Although atomic energy will be competitive with hydrocarbons as a source of energy and may well create a price ceiling that prevents increasing prices for oil in view of increasing costs, atomic energy will be used in many fields

Gilbert H. Tausch

Director of Engineering for CAMCO, INC. For many years prior to joining CAMCO, Mr. Tausch was an engineer for Humble Oil & Refining Company.

as a source of power and self-contained subsurface pumps run by atomic energy will be set in many wells. The ability to obtain heat from atomic energy will permit subsurface cracking of crude oil to produce natural gas and thereby lift the gas and oil to the surface as a means of artificial lift. The degree of cracking will again match market demands and complement refining capacity.

Reservoir Operations to Use Radical Ideas

Secondary recovery is probably the only field of endeavor in which radical ideas are already being tested in laboratories. No scheme is too absurd. In the laboratory a "breakthrough" to 100 percent oil recovery has already been accomplished by the LPG or enriched gas drive type injection. Although this type secondary recovery has been reduced to field practice, the economics are not always favorable in the light of current conditions. Laboratory work is also continuing on other gases, such as CO_2; thermo processes, such as insitu-combustion and steam; the addition of chemicals to flooding agents that alter the surface tension or wetting characteristics of the trapped oil, flooding agent or both. Many of these processes have proved satisfactory in the laboratory and a number have been reduced to field practice.

Recovery Efficiencies to Increase

Approximately twice as much oil remains trapped in abandoned or marginal properties as was recovered during initial producing operations. In view of increased finding and developing costs, increased operating costs for "exotic" secondary recovery processes become more feasible. The amount of oil remaining in present reservoirs and available for 100 percent oil recovery does not present a realistic picture of future recoverable oil when a process capable of recovering 100 percent of the oil in the contacted area only contacts 50 percent of the reservoir volume. Therefore, the quantity of recoverable oil may be increased greatly by increasing the conformance efficiency of the flooding agent.

This process will be aided in the future by close coordination between reservoir analysis and well operations when diagnostic services are available to indicate the zone of flushing and when economical reworking operations permit altering the flooding pattern. Many secondary recovery techniques being tested in the laboratory today will be utilized in the future with excellent results when coordinated with the above mentioned services.

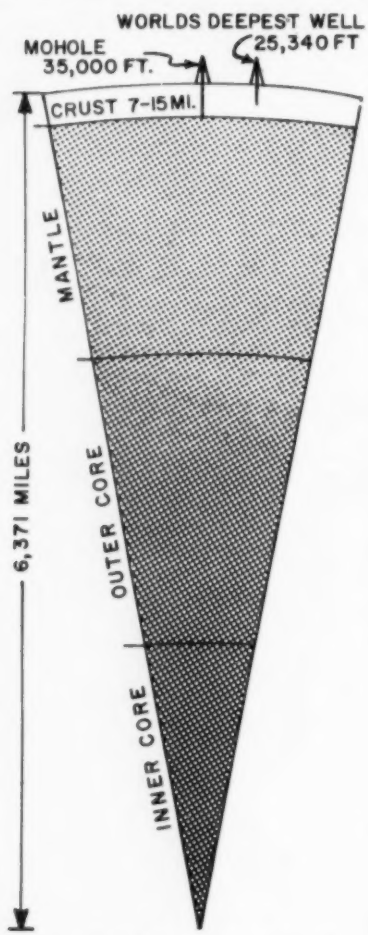
Acknowledgment

The author wishes to credit many oil industry men for their contribution of new ideas concerning the tools or methods briefly described in this article. More details concerning these tools may be found in previously written technical literature and trade journal articles. ★ ★ ★

Operation Mohole

The first full-scale drilling project designed specifically to probe below the earth's crust is underway! Mid-ocean test may go 35,000 ft subsea

Willard Bascom, *Technical Director of the AMSOC Committee, National Academy of Sciences, Washington, D. C.*



A cross section of the earth from the surface of its outer crust to its inner core. The objective of the Mohole is to penetrate the first inner zone called the "Mantle."

What lies beneath the earth's crust?

Earth scientists and oilmen are mustering all available geological and geophysical data, deep drilling techniques, scientific and engineering knowledge, and financial assistance to answer the age-old question.

A project is now being planned to drill a hole completely through the oceanic crust to obtain samples of the mantle — probably to a depth of 30,000 ft. The mammoth undertaking is sponsored by the AMSOC committee of the U. S. National Academy of Sciences. Current plans suggest that the project will be a two-phase program. The first phase would test deep-drilling techniques and sampling upper layers.

The undertaking is called the Mo-

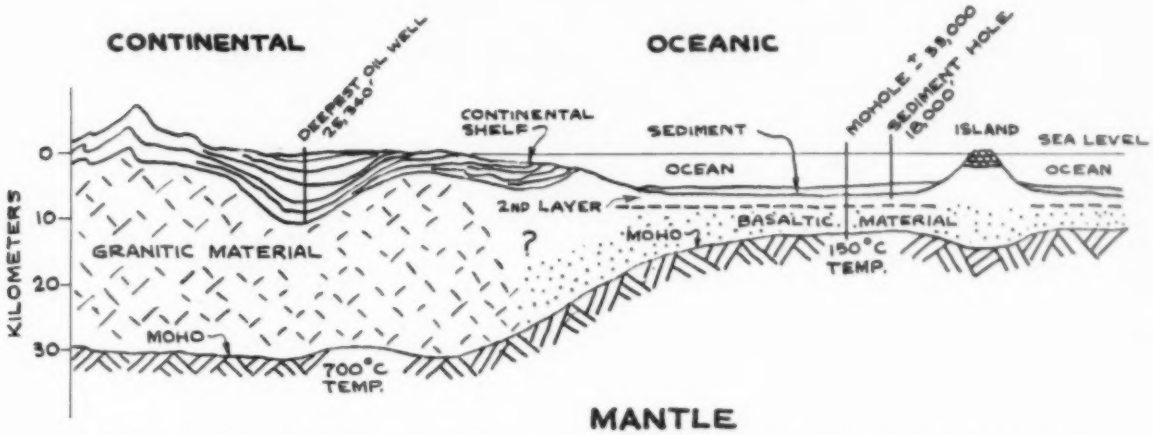
■ What's AMSOC?

The American Miscellaneous Society, or AMSOC, was founded in 1952 as a whimsical spoof of scientific societies which are sometimes too specific for their own good. Its cable address, AMSOC, is well known in the alphabetical world of Washington. Because it has no formal members, officers, by-laws or publications it is, of course, a very efficient group. It has close ties with the Committee for Informing Animals of their Taxonomic Position and the Committee for Cooperation with Visitors from Outer Space.

On the subject of drilling through the crust of the earth however, the AMSOC group is quite serious and has been formally organized so that it can receive funds from the U. S. National Science Foundation. Its original members were: Gordon Lill (chairman); Professor Maurice Ewing; Dr. William Heroy; Professor Harry Hess; Dr. Harry Ladd; Dr. Arthur Maxwell; Professor Walter Munk; Professor Roger Revelle; Dr. William Rubey; Dr. Joshua Tracey, and Willard Bascom (technical director).

The Mohole project, in more or less its present form, was born at a breakfast at Professor Munk's house at the Scripps Institute of Oceanography in California at which he and Professor Hess led the conversation in the need for a geophysical analog for the space exploration program. AMSOC proposed a deep drilling project.

It is significant that in the following September, at the meeting of the I.U.G.G. in Toronto, a resolution was passed "urging the nations of the world — to study the feasibility and cost of an attempt to drill to the Mohorovicic discontinuity at a place where it approaches the surface." A hole 10 to 15 Km. deep on an oceanic island was suggested. The sponsors were Harry Hess, Roger Revelle and T. F. Gaskell.



This schematic cross section of the earth's crust and upper mantle shows why it will be much easier to reach the Moho at a deep water ocean location. A continental location might require a well depth of 100,000 feet; and oceanic island location perhaps 50,000 feet; but possibly only 30 to 35,000 feet at a selected deep water ocean location.

hole project, named for the prime objective of the hole — the Moho, the indefinite and little-known boundary between the earth's crust and mantle. The word Moho comes from Professor A. Mohorovicic of Yugoslavia, who first described the seismic discontinuity at that point.

Where will the Mohole be drilled? How deep will it be? How much will it cost? Who will pay for it? When can it be drilled?

These are questions that are now being solved. Although it was first suggested that the hole be drilled from an oceanic island to a depth of 33,000 to 50,000 ft, it is now believed possible to probe the Moho more easily from a floating drilling platform anchored in open ocean, where the earth's crust is the thinnest. At certain locations where the water depth is from 10,000 to 18,000 ft, the Mohorovicic discontinuity may be penetrated at 28,000 to 35,000 ft below the ocean surface. This means only 13,000 to 18,000 ft of actual drilling. How hard the drilling will be is anyone's guess.

Total cost of the preliminary tests, equipment and actual drilling is estimated at $15,000,000. The AMSOC group has now been formally organized so that it can receive funds from the U. S. National Science Foundation and from private interests to finance the Mohole.

Drilling the test holes could begin this year. Collection of needed data and re-evaluation of the most promising areas are under way.

What materials must be drilled through? What is expected to be found?

Structure Theory

The structure and material of the earth's interior is a puzzle which has long challenged the mind of man. In all major aspects the most acceptable present hypothesis holds together very well. This is remarkable, for it requires that there be reasonable agreement between at least eight sub-sciences, all of which make indirect measurements. Studies of astronomy, meteorites, volcanoes, geologic structure, gravity, seismic waves, the magnetic field, and heat flow each contribute to the total knowledge.

If one assumes that meteorites are the wreckage of a planet similar to earth and that the rocks spewed out by volcanoes (whose seismic precursors begin well below the Moho) contain samples of mantle material, then we already have samples of the deep rocks. Dr. Harry Hess, Department of Geology, Princeton University, believes that mantle rock actually outcrops (at St. Paul's Rocks in the mid-Atlantic, in Japan and in California). Astronomical observations give the total mass, the average density and the moment of inertia of the earth.

Evidence about the structure of the earth has come primarily from earthquake waves. Seismologists have worked out characteristics of the planet which keep within the limits set by the other evidence.

Mantle

The hypothesis of inner and outer cores surrounded by a thick mantle and capped with a thin crust has stood the tests of many years; now the problem is to refine the information and to obtain evidence which cannot come from further advances in seismology. Composition of the mantle which represents about 85 percent of the volume of the earth is the principal problem of geophysics today, for although a lot is known about it, uncertainties remain.

Exact mineralogical and rock composition, density, strength, temperature, amount of radioactivity, thermal and electrical conductivity — all of these will contribute immeasurably to the understanding of the earth and its origin. Moreover they will serve to enhance the value of the indirect geophysical measurements. Finally, some new and entirely unexpected piece of evidence may be unearthed that will cause science to revise substantially its concept of the earth.

Floating Crust?

The crust is closer and easier to study than the interior — but also more controversial. Generally it is agreed that continents represent relatively thick blocks of andesitic rocks and that ocean basins are composed of much thinner basaltic rocks — the average thicknesses being about 30 Km and 10 Km respectively. The crust

seems to act as though it is floating on viscous plastic mantle material; however, the response time is long and certain anomalous areas not in isostatic equilibrium complicate the problem.

The Moho, which defines the boundary between crust and mantle, is recognized by an abrupt increase in the velocity of seismic waves — from around 7.0 Km per sec to 8.2 Km per sec.

As the earth developed, the water which reached its surface naturally ran downhill and covered the lower, thinner basaltic material forming an ocean.

Composition of the oceanic crust is studied by sea-going seismologists who use pairs of ships — one setting off explosions, the other listening. In this way it has been discovered that beneath much of the ocean there are three main layers of material: (1) The soft sediments, (2) the "second layer," and (3) the "crust." (Fig. 2.)

Soft Sediments

The soft sediments of the deep sea floor (red clays and calcareous oozes) have been repeatedly sampled with cores which have penetrated as much as 20 meters into the bottom and reached as far back as Cretaceous time.

The seismic evidence suggests that they are remarkably uniform in thickness, averaging about four-tenths of a kilometer. Unfortunately, this is far too thin to agree with the figure one gets by multiplying present sedimentation rates by the supposed age of the oceans. So one very large question to be answered is, "What happened to the rest of the sediments?" Moreover, it seems possible that the record of early evolution, missing on land, could be preserved in the lowest sediments.

Second Layer

There are at least four theories about the composition of the "second layer" — all of which begin with the knowledge that it conducts seismic waves at 4.5 to 5.5 Km per sec. It may be compacted sediments, basalt, dolomite or more soft sediments screened by a layer of basalt; usually it is one to two kilometers thick.

Crust

The third layer or "crust" has a seismic velocity of about 6.5 Km per sec; it is commonly called basalt but as Hess points out this is more a matter of 150 years of tradition than of evidence. In fact, some scientists doubt that there are as many as three layers; others think there are more.

What Is Moho?

One of the interfaces (possibly the Moho) may represent the primordial surface of the earth. It may have a surface something like the face of the moon today; it may be covered by a layer of meteoritic material or perhaps a conglomerate. It may give evidence of our early atmosphere and ocean, or it may have been altered beyond recognition. These speculations have served to make the proposed exploratory holes even more exciting.

Many of these suggestions have been discussed and debated in the literature. Harry Hess believes that the Moho represents a frozen isotherm; J. F. Lovering thinks it represents a temperature pressure relationship which has caused a phase change from an ecologite mantle to a basalt crust. Tuzo Wilson believes that continental andesitic material must be rising from the mantle — from greater depths than the basalts. He notes that K Sapper's figure of 0.8 Km^3 per year over geologic time would account for the volume of the continents and that a slightly higher rate of volcanism in the early stages would allow for the emission of an oceanic crust as well. Harold Jeffreys believes that the ocean crust is too rigid to permit sidewise motion of the continents but recently there has been renewed interest in Wegener's continental drift theory. There are points of disagreement on the distribution of radioactivity, on the interpretations of seismic velocities, and on the causes of oceanic trenches.

The very fact that there is not agreement is a good reason to do some direct exploration (if there were no controversy there might be even greater suspicion that something was wrong).

Coring

Some of these questions will be resolved if a continuous core of the various layers beneath the sea floor can be brought into the laboratory for study and analysis. In addition, in the hole from which the core is taken, measurements can be made of temperature, heat-flow, the magnetic field, plastic deformation and seismic velocity.

It is therefore the objective of the AMSOC Committee to see that a continuous, oriented core to the mantle is obtained and that the hole(s) are thoroughly instrumented. Some of the instruments already exist; others will have to be developed or miniaturized to fit in the hole (which will be about 4-in. in diameter at the bottom).

No geologist or geophysicist doubts the value of such data; the question is, "How can it be done, and for how much money?"

In *Nature* of September 13, 1958, Dr. Gaskell examined some of the technical problems of deep-hole drilling. However as AMSOC's feasibility study progresses, new objectives have been developed and new drilling technology has been uncovered so that now Gaskell's thoughts need to be updated. For example, the idea of drilling from an oceanic island has been abandoned because recent studies indicate that the mantle is as deep as 17 Km under the islands that have been studied.

Developments in floating drilling platforms make it appear that deep-water drilling is feasible in any case; besides, we need the sedimentary data.

Temperature No Problem

A review of the temperature situation suggests that temperatures in the mantle immediately beneath the ocean crust will be less than 200 C. At several sites where seismic work has been done, the total reach of the drillstem from the water surface to the mantle will need to be only 30,000 ft. Thus as the project develops, the objectives seem more attainable with less difficulty and expense.

Table 1 shows the length of drill

TABLE 1. Reach of Drill Required to Achieve Various Objectives.

	PHASE	PACIFIC						ATLANTIC	
		Clipperton Island area 10°—53'N 105°—09'W		Guadalupe Island area 28°—45'N 117°—31'W		Due South of San Diego, Cal. 5°—47'N 123°—59'W		North of Puerto Rico 20°—40'N 66°—30'W	
		Km.	Feet	Km.	Feet	Km.	Feet	Km.	Feet
Depth of water	I	3.1	10,100	3.5	10,700	4.3	14,000	5.5	18,000
Depth to bottom of sediment	I	3.3	10,400	3.6	10,900	4.8	15,700	6.0	19,600
Depth to bottom of 2nd layer	I	4.2	13,800	5.2	17,000	5.5	18,000	8.0	26,200
Depth to Moho	II	8.6	28,100	10.8	35,500	9.7	31,800	9.6	31,500

Note: Geophysicists think in kilometers but drillers work with feet.
Pacific data from R. W. Raitt, Scripps Institution of Oceanography.
Atlantic data from J. Worzel, G. Sutton, et al, Lamont Geological Observatory.

pipe required to reach the surface of various layers beneath the sea floor at four sites which are under consideration.

Two-Phase Program

Inspection of these figures shows that a drill reaching to 6 Km (20,000 ft) will return data on the upper three layers. Beneath that it is another 3 to 5 Km to the Moho. For this reason the project will be divided into two phases. The first of these involves the modification of existing equipment for drilling holes in the upper layers.

The second phase — which will take us on to the Moho — will probably require a completely new engineering design for the total length of the drill pipe must be well over a mile beyond that used in the deepest oil well to date (25,340 ft hole by Phillips Petroleum Company in West Texas).

Testing

It is generally assumed that no one site or hole will satisfy all the requirements of Mohole.

The final hole to the mantle must be drilled where the geologic situation is uncomplicated and where the Moho is closest to the surface. To locate that place, seismic, gravity and heat flow surveys must be conducted.

One possible location is on the abyssal plain some 200 miles north of Puerto Rico, where the water is 18,000 ft deep and the Moho is about 14,000 ft below the ocean floor. Even more promising locations are located in the Pacific Ocean, as indicated in Table 1.

Initial test sites, designed to test equipment, are also expected to yield important information about sedimentation.

The ideal site would be the lowest spot on the original earth surface into which the earliest waters drained and brought sediment. Here continuous layers of sediment would represent the entire history of the earth. Paleontologists have fond hopes of recovering cores of fossil-bearing formations older than the Cambrian.

In addition to geological location problems, weather, accessibility to supply points, strong currents and rough seas must also be considered.

Objectives of phase one would be to obtain the best possible samples of the upper layers while testing out deep-water drilling methods. For example, no one is sure how closely a ship must be held in position in deep water while it drills but several schemes have been proposed which would probably keep it within a circle the diameter of which is less than three percent of the depth (12,000 or so ft of water). Forces due to the drag of ocean currents on the drill pipe and casing are as yet unknown because of the lack of reliable deep-current data. Questions of how often casing will have to be run and how it will be supported; of how well the soft sediments can be cored and if sea water is a satisfactory drilling fluid will be answered by the first test holes.

There are four floating platforms which mount intermediate-depth oil rigs drilling in shallow water off the coast of the United States.

Many of the problems of ocean drilling have been ingeniously solved by these operators so that only minor modifications of standard drilling techniques are needed. Several ways have been found for re-entering the hole and recirculating drilling muds; these require that a riser pipe, conductor or casing reach to the surface. It is even possible to temporarily abandon a hole and recover it again.

Equipment Available

In depths of 35 to 360 ft, holes have been drilled to nearly 12,000 ft. CUSS I for example, now drilling for oil off the California Coast, is a well designed vessel that would make an excellent deep-drilling experimental platform if it were equipped with a heavier drawworks (such as are available) and a deep mooring system.

Holding a ship in position in water two and a half miles deep might be accomplished by (1) anchors which are explosion-jetted into the bottom and connected to the ship by neutrally buoyant hawser lines of synthetic material; (2) a dynamic anchoring system in which a group of outboard propulsion units (which can exert propulsive force in any direction) are centrally controlled by an operator who holds his position by watching taut-line buoys and/or listening to a vertical beam of underwater sound rising from a transducer fixed to the bottom.

Thus, the mooring, drilling, setting of casing and riser pipe, coring and instrumentation all appear to be well within the bounds of our technology. Engineering design work has started; so has agitation for funds.

Drilling Cost

As the feasibility study progresses, the original cost estimates have shrunk and it now appears that the entire project might be carried out for about $15 million. This is not an inconsiderable sum but it is far less than that of a rocket propelled "moon probe," whose ostensible objective is to learn about the nature and origin of the solar system. It seems a little foolish to go off to look at the moon when we don't know what lies a few kilometers beneath us on the home planet.

The first phase could be accomplished for about $2.5 million; the second for about $7.5 million. It is hoped that the project will be funded jointly by private interests and by the U. S. National Science Foundation. Certain related aspects of oceanography and of doing heavy work at sea might be supported by the U. S. Navy although there is foreseen no direct military application.

Spudding Date

When drilling will start is uncertain, depending on the length of time to complete preliminary work and to obtain funds. It *could* begin on the test holes before the end of 1959. The scientific planning of objectives, locations and instruments; the collection of needed data and the resurvey of the most promising area is already under way.

Then by trial and error, test drilling can begin. It must then be found out how to set up and drill in open ocean without getting pipe and lines in a hopeless snarl. The proper drilling fluid must be found, as well as the proper drilling bits to penetrate the basalt or whatever hard structure lies beneath sediments on the ocean floor. Coring and sampling techniques must be worked out, first in drilling them, then getting them safely to the surface, finally in preserving them.

After these problems are solved, then modifications for the Mohole itself can be made. It is expected that as much as 1600 ft of soft sediments must be drilled — then the hard-rock road to Moho can begin. This hole to the mantle will be very difficult; no one has illusions about this. It is not even known that the Moho can be recognized when it is reached!

Whatever is found, much will be contributed to the knowledge of this planet. AMSOC believes that Operation Mohole is likely to produce the greatest advances in man's knowledge of the earth in our time.

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Underground Nuclear Explosions:

THE CENTURY AHEAD

Awesome Recovery Promise

"Operation Plowshare," the government's program devoted to the development of peaceful uses of atomic explosions, includes steps to the use of confined atomic blasts for fantastic petroleum recoveries

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FOR SEVERAL YEARS, atomic energy has been at work for the petroleum industry in several applications. Neutron logging, gamma ray logging, and the use of radioactive markers and tracers are a few of the jobs done by the atom that are most familiar in the drilling and producing end of the business. More recently, radioactive energy has been put to work measuring and indicating the weight of drilling fluids and cement slurries.

Industry does not need a crystal ball to see many more applications of nuclear energy to come. Drilling men will one day harness nuclear forces for rock destruction in drilling holes deep into the earth. Nuclear reactors will supply heat to petroleum reservoirs for tremendously improved recoveries from "depleted" formations, tar sands, and oil shale. Reactors will also generate great power to drive equipment in all phases of the industry. And even more exciting is the prospect of the tremendous confined forces of an underground nuclear explosion.

Plowshare Program

The government's program to encourage the use of nuclear explosions for peaceful purposes is called "Plowshare." In this program the projects of prime interest to the petroleum industry are (1) the breaking and heating of oil-bearing rocks in petroleum reservoirs and tar sand deposits, and (2) the fracturing of oil shale to prepare it for either mining or thermal recovery by the in situ combustion process. The discussion will proceed from what is known about underground nuclear explosions to possible applications. With reference to underground nuclear explosions acknowledgment is made for drawing heavily from the material contained in the University of California Lawrence Radiation Laboratory reports UCRL 5124, UCRL 5124 Revision 1, and UCRL 5253. (The three illustrations used in the present paper are from UCRL 5124 Revision 1.) The first two reports deal with underground nuclear explosions and the last one discusses some potential industrial uses under the Plowshare program.

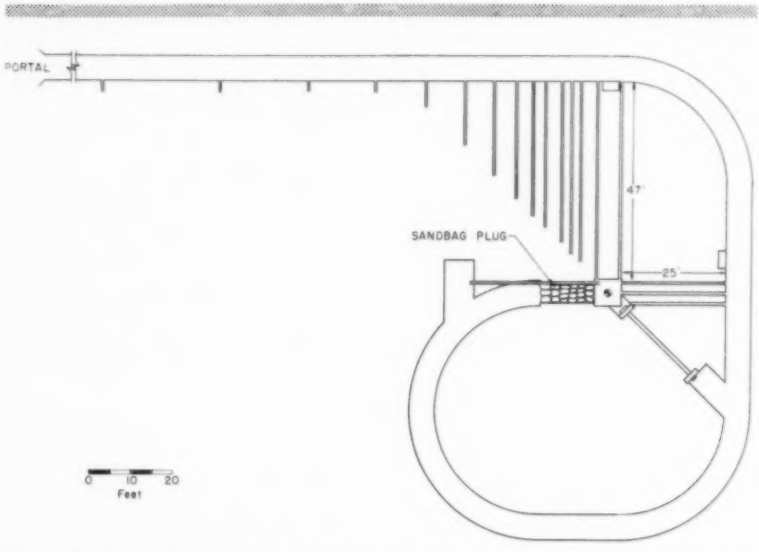

FIG. 1. **Tunnel configuration** used in the Rainier test was designed to seal itself by collapse before any radioactive debris could project around the spiral and out the tunnel.

Rainier Test

The first underground nuclear detonation designed to be fully contained occurred September 19, 1957, and is known as the Rainier test. The shot had an energy release equivalent to 1700 tons of TNT or an energy yield of 1.7 kilotons. One ton is defined as 10 to the ninth power calories or about four million British thermal units. Thus the total energy release of the Rainier test was 6.8 billion Btu, which is approximately equivalent to the energy released in burning 6.8 million cu ft of natural gas.

The device was placed in a mesa or mountain at the Nevada test site so that the vertical distance to the surface was 899 ft, and the distance to the nearest surface point was 790 ft at the sloping face.

The rock formation of the mesa is Oak Springs tuff, a volcanic material that was deposited in Tertiary time. A dense limestone underlies the Oak Springs tuff. Over the limestone there is a series of generally distinguishable beds of tuff. Six of these are described as bedded and vary from the loosely cemented and "sandy" one in which the device was placed to well cemented tuffs. The other two, one of which forms the cap rock of the mesa, are described as welded tuffs.

The cap rock of welded tuff is 250 ft thick. Its porosity is 15 to 25 percent, and the permeability is low, resulting in only partial saturation with water. The 600-ft interval below the cap rock consists mostly of loosely cemented granular volcanic material having a porosity of 25 to 35 percent and apparently fully saturated with water. Percentage of water by weight

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was 15 to 20 and determinations showed that 25 to 35 percent of the voids were connected. Permeability determinations were not made. However, heating the rock at 230 F drove off 80 percent of the water. The compressive strength of the rock is 5000 to 10,000 psi.

Blast chamber. A tunnel was driven on a horizontal plane and terminated in a spiral designed to seal itself by collapse before any radioactive materials could move around the spiral and escape. The device was placed in a 6 ft by 6 ft by 7 ft room. The entrance of the room was plugged with 13 ft of sandbags. Besides this, two steel doors strong enough to withstand a pressure of 75 psi were placed 575 ft and 1225 ft from the point of detonation.

Firing was by remote control 2.5 miles away. At this point the vibration was so weak that only a few people felt it, and a muffled explosion was heard. Measurements indicated the top of the mesa, directly above the shot, rose 9 in. and at horizontal distances of 1000 ft from the device, the vertical uplift at the surface was less than ½ in.

Indications were that the radioactivity was contained, although some undetected small leaks may have occurred. Radioactivity inside the tunnel was the same as the normal background measured before the explosion. The tunnel to the 575-ft door was intact with only minor spalling and a slight shift in bedding planes at one point. At 400 ft from the device there was considerable spalling and at 200 ft the tunnel had collapsed.

Investigation of blast zone. A rig designed to operate by remote control, if necessary, drilled normally from the top of the mesa until a cavity was struck 386 ft above the point of detonation. This happened November 1, 1957. The radiation level and temperature in the cavity were normal. The cavity was 25 ft deep and pictures showed it to be conical in shape. From that point to the floor of the test room the space was filled with broken tuff and sand. No returns were obtained during the drilling of this section and no pressurized zones were encountered.

Following this, a drill was set in the tunnel about 211 ft from the point of detonation and holes were drilled into the cavity region. The radioactivity was found to be concentrated in a bowl-shaped shell having a radius of about 55 ft. Fused glass-like material was found to comprise a large part of this shell and it trapped and retained almost all of the radioactivity. Highest temperature found was 194 F. Temperature distribution in a vertical plane surrounding the detonation point, five months after firing, was not symmetrical, possibly because the tunneling had influenced somewhat the direction the reaction took which in turn, influenced the deposition of the fused material containing the radioactivity. The temperature of the surrounding tuff is 61.9 F, and temperatures within ranges of 80 to 160 ft of the shot point varied from 62.6 F to 176 F.

Sequence of events. The events following the explosion have been reconstructed. Immediately after firing when the energy was distributed in the test room, the calculated temperature was 1,000,000 K, or roughly 1,800,000 F, and the pressure was 7,000,000 atmospheres. The shock vaporized rock for the first 3 ft and rock was melted out to 15 ft. Outside of this sphere the rock was crushed to a radius of about 130 ft and the molten sphere expanded to a radius of 55 ft in several milliseconds. Then the 55-ft sphere was lined with 4 in. of molten rock at a temperature of about 2220 to 2730 F. This molten rock came from the 15-ft radius sphere. Steam produced from water originally in the tuff filled the 55-ft radius sphere to a pressure of about 40 atmospheres, causing the cavity to stand long enough for molten rock to drip from the ceiling and flow down the sides. This took between 30 seconds and 2 minutes. Then the cavity collapsed, permitting steam to expand and cooling became rapid.

The cavity was filled with broken rock. Some 200,000 tons of broken rock resulted from this collapse. The molten rock cooled rapidly because of the refluxing water which rapidly brought the temperature down to 201 F, the boiling point of water at 6600 ft elevation. The molten rock was converted to glass that contains all radioactive fission products excepting the rare gases. Calculations show that one half of the total energy released by the device remained locally in the form of heat.

The crushed zone between radii 55 and 130 ft in the Rainier test was compacted to such an extent that it has little or no permeability. It is impermeable to water. The fractured or broken zone is permeable to water, but no permeability tests were made before or after detonation. This is the most interesting zone to petroleum engineers.

Shape of the crushed and fractured regions should be noted. The horizontal dimension in the Rainier test is 110 ft and the vertical is 386 ft. These relationships may or may not prevail for nuclear explosions in formations not similar in properties to the Oak Springs tuff. Obviously applications in petroleum reservoirs, tar sand deposits and oil shale introduce many new factors.

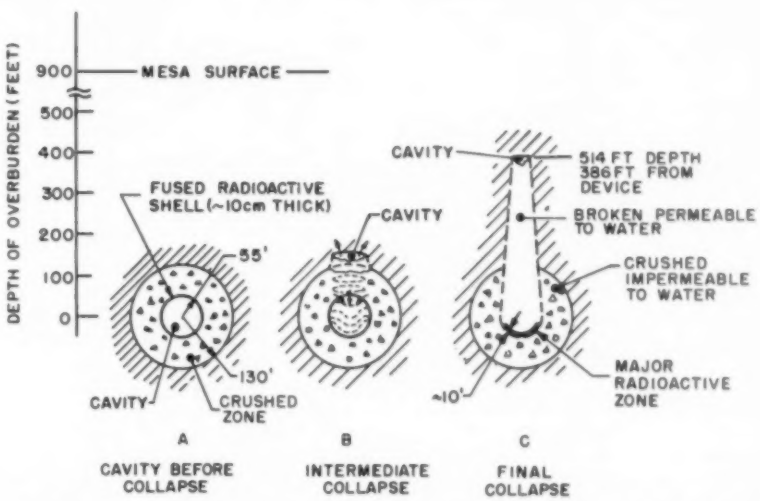

FIG. 2. **Reconstructed picture** of strongly affected zones surrounding the detonation point shows the sequence of events in the collapse of the cavity.

Oil Shale Experiment

In the Plowshare program, the Bureau of Mines considered both oil fields and oil shale. Preference was given oil shale because much was known about the rock characteristics. In particular the thickness of the beds fit the configuration of the crushed and featured zone created by the Rainier test. Also the rock contains about 35 percent silicates to trap radioactive fission products and the shale contains almost no water. Thus some important criteria appeared to be met.

Oil shale technology. In this country oil shale technology is in an early stage of development. Undoubtedly many advances will be made, but improvements in conventional methods may not result in spectacular reductions in costs. Hence new and unconventional meth-

ods should be investigated to determine whether major cost reductions can be made.

Nuclear explosives and the in situ conbustion process might eliminate mining which represents about 50 percent of the present cost of producing shale oil. Also shale preparation or crushing might be eliminated, saving another 15 percent. If the theory proved accurate, the explosion would construct, in effect, an underground retort charged with broken shale. These benefits, however, are offset by other cost items such as that of the nuclear device, large hole or shaft for placing

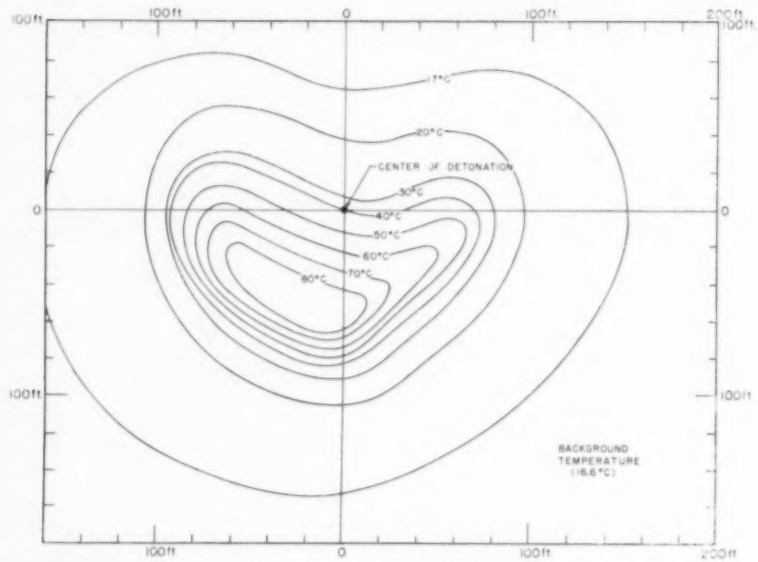

FIG. 3. **Temperature profile** in vertical plane surrounding the Rainier detonation point was determined by logging potshot holes drilled in the plane. Temperatures were measured five months after the detonation.

shot, air injection and producing wells, a compressor station and other equipment plus operating costs. Thus both technologic and economic studies are required to ascertain the feasibility of the project.

The study was made for the Green River oil shales that occur extensively in Colorado, Utah, and Wyoming. Although Colorado oil shales are the smallest in areal extent, they have a reserve of a trillion barrels of oil in place and more is known about them than the shale deposits in the other two states.

An important oil shale deposit is in the Piceance Creek Basin of northwestern Colorado. It covers about 1200 square miles, being about 40 miles by 30 miles. Along the southern edge of the basin the richest beds of oil shale, known as the Mahogany Ledge, crop out about 500 ft below the tops of the cliffs overlooking the Grand Valley of the Colorado River. Here the section yielding 25 gal of oil per ton is about 80 ft thick and increases to 200 ft near the Rio Blanco County line. Northward the 25 gal per ton section thickens to about 1900 ft in the central part of the basin and the shale has a maximum thickness of 3000 ft.

All of the evidence at hand suggests that an experimental test site can be selected in this basin that will meet the criteria for complete containment of the explosion and entrapment of the radioactivity in the fused material resulting from the reaction. Of course, any site considered will have to be evaluated in detail to assure the protection of public health and safety.

Oil shale properties. The Green River oil shale and the Oak Spring tuff are very dissimilar in properties. This oil shale has compressive strengths ranging from 15,000 to 25,000 psi, whereas the figures for tuff are 5000 to 10,000 psi. Dr. Charles E. Violet of the University of California Lawrence Radiation Laboratory computed the crushing radius for a 10-kiloton explosion in oil shale. Based on the Rainier test and assuming oil shale and tuff had the same physical properties, the 10-kiloton yield would give a crushing radius equal to 130 ft times the ratio of the cube roots of the yields; namely the cube root of 10 divided by the cube root of 1.7. This equals 235 ft.

However, oil shale is probably twice as strong as tuff and for high pressures the pressure declines about as the inverse square of the distance. Hence, the crushing radius for oil shale is calculated to be about 235 ft times the square root of ½, or 166 ft. Bureau experience with high explosives in greenstone, a rock that is as strong or stronger than oil shale, gives a crushing radius of about 100 ft for a 10-kiloton detonation. Thus it is thought the radius of the crushed zone may range from 100 to 200 ft.

The minimum figure was used in evaluating the crushing and fracturing effects. Due to the strength of oil shale it is unlikely that caving into the cavity would be as extensive as in the Rainier test. In oil shale the caving may extend only to producing a cone with sides sloping 45 to 60 deg from the horizontal. Or, the explosion could produce a chimney-type fractured zone like the experience in tuff. If this happens more shale may be broken than estimated.

Based on a radius of 100 ft and a 45-deg slope of sides of the cone there would be approximately 300,000 tons of shale shattered. More than half of this should be above the detonation point and should be permeable, but the degree of fracturing cannot be predicted with any certainty. Placing the device below the rich beds would cause them to fracture and cave into the cavity, resulting about 25 gal-per-ton material for the in situ combustion. Less than half of the broken shale originally lying below the detonation point may be too tightly compacted for processing. This shale would contain only 15 gal of oil per ton.

Effects of detonation heat. The heat from the explosion would produce some oil and gas from the organic matter in the shale. Quantities of these products would depend on the grade of shale, temperature history and other factors. If half of the energy released by the device, or 20 billion Btu, were used in retorting average grade oil shale at 900 F, it would be enough to produce about 10 million cu ft of gas and 15,000 bbl of oil. Because of the very high temperatures and pressures produced by the explosion, it is unlikely that the quantities of hydrocarbons formed would bear any simple relation to those calculated. Water content in the oil shale is less than two percent so cooling by water vapor should be less than in the Rainier test. However, cooling or quenching might occur through cracking, distillation and refluxing of the oil products.

After the explosion the geometry of the broken zone would be explored by core drilling to determine extent and degree of fracturing. This and other data would be required to design an in situ combustion process and plant to recover shale oil from the fractured zone.

A cost estimate for the whole experiment, nuclear detonation, and in situ combustion retorting of the shale

is about $2,600,000. The large items are $355,000 for site preparation and driving a tunnel for emplacement of device, $1,000,000 for the nuclear explosive and related charges, and most of the remainder for the equipment and wells for the in situ combustion process, its operation and related work.

Cost Estimate for Producing Shale Oil

The experiment would produce the technical data needed for a feasibility determination. Lacking these data, it is now impossible to develop an accurate cost estimate for producing shale oil by this method.

Cost of device. Taking up the cost of nuclear explosives and related charges, the unit cost of energy is reduced greatly by using large yield devices. That is, the differences in costs of devices in the hundreds of kiloton and megaton sizes are small in relation to the differences in yields of energy. Hence to make a reasonably favorable economic analysis it is necessary to use a 300 kiloton or larger device. The exact size is not known because experience in oil shale is lacking. However, this is not too serious as cost for large sizes is almost independent of energy release and approximates $1 million.

A large yield device, 300 kiloton or larger, can be selected to shatter 35 million tons of oil shale which might assay 28 gal per ton. Experience in volcanic tuff indicates 3000 ft of cover is required for a 300-kiloton explosion. Having no experience in oil shale the 3000-ft figure is used.

Cost of hole. Sizes of holes for nuclear explosives vary, but for a few kilotons to a few tens of kilotons the hole must have a minimum diameter of 30 in. and for devices ranging from a few hundreds of kilotons and over the minimum diameter is 60 in. In this example the estimate is based on a 72-in. hole to allow for guniting or casing of the hole.

Estimates of $162 to $335 per ft were obtained for drilling a 72-in. hole and lining with guniting. Because no one ever drilled a 60 or 72-in. hole this deep, two drilling costs of $200 and $400 per ft are used.

Recovery factor. The recovery factor is based on 14 underground tests conducted by the Germans of which the two best yielded 46 and 56 percent. For this estimate a recovery of 47 percent was selected. This will give an average daily production of 3000 bbl or 11 million bbl in 10 years. Not knowing the configuration of crushing and fracturing in oil shale, the configuration of the 35-million ton project is assumed to be 1000 ft in diameter and 650 ft in vertical dimension.

There are no rock fracturing and permeability data available for oil shale in the condition it will be found after the detonation. This is essential for the planning of an efficient well pattern for the in situ combustion progress. However, lacking this information, the study proceeded by assuming the well pattern to consist of 13 air-injection wells on approximately 240-ft centers on the outer circumference and 13 producing wells 240 ft inside the circle of injection wells. The completed pattern has 27 wells, including the center well. If 13 wells are allowed for exploration and redrilling, the total is 40 wells. The inner circle of wells are only 60 ft apart and may be more than needed. Experience may show that 30 wells will be enough and the low estimate is based on 30 wells. The cost of completed wells is estimated at $10 per ft.

Production procedure. The procedure is to produce the outer area or annulus first, then the inner wells will be converted to air-injection wells and the center well will be the producing well until the project is completed. The amount of section opened in the air-injection wells at a given time will be determined from the air velocity required for optimum retorting and oil recovery. From Bureau retorting experience the air requirement for the project was computed to be 26.2 million std cu ft per day, giving an air to oil ratio of 8.7 thousand cu ft per bbl.

Air pressure requirements are unknown, but if a pressure of 600 psi is needed, the compressors will require 8400 hp at the elevation of the oil shale deposit. If only 300 psi is required, the project needs about 6600 hp. Unit cost of compressors including installation is estimated at $300 per hp.

Cost of tank batteries, heaters, pumping equipment, and pipelines is estimated at $250,000. For field operations including lifting costs a figure of 50 cents a bbl is used. Well maintenance probably will be costly, but it is thought this figure will be adequate. Compressor operation, maintenance, and fuel costs are estimated at $60 per hp-year.

Project is planned to operate 10 years, with capital costs depreciated and amortized over this period. Furthermore, the estimate assumes a fixed earning on invested capital to determine the unit cost of producing shale oil. Earning is fixed at 12 percent per year on the total investment or an average earning of 21 percent per year on the net investment. Income tax is computed at 50 percent.

Total costs. Based on the foregoing assumptions and cost figures, the capital expenditures for the high and low conditions are $6,170,000 and $4,730,000. These very roughly estimated costs, capital and operating, result in a high estimate of about $2.90 a bbl for shale oil and a low figure of $2.35 a bbl. These costs could be reduced about 10 cents per bbl by programing two shots in series to permit depreciating and amortizing compressors and other surface equipment over a 20-year or normal life period. Thus the indications are that costs, including normal profit, may fall somewhere between $2 and $3 per bbl for this method.

This very preliminary study shows that the nuclear explosive and in situ combustion process may be economically feasible for producing shale oil. The analysis also shows clearly the need for good technologic data that are essential to the preparation of an accurate feasibility determination for the process.

Petroleum Reservoirs

Depleted oil fields have been suggested as likely sites for an experiment. Some of these may have desirable characteristics, but it seems more likely that the first test might conceivably be in a reservoir, either newly discovered or old, that has a pay section of some 100 to 200 ft and a high saturation of viscous crude oil. In such a reservoir the relative proportions of the Rainier-type explosion can be accommodated satisfactorily. The device should be detonated below the producing section to minimize the destruction of crude oil in the blast and cause as much fracturing in the oil producing section as can be attained. Obviously the rock at the point of detonation should have a satisfactory silicate content to fuse and retain the radioactive fission products. The cap rock should not be broken by the explosion as this would permit migration from the reservoir. Also the structure must have edge and bottom water conditions that will not cause adverse water conditions in producing the property following detonation.

In a reservoir containing a viscous or waxy crude oil, both the fracturing and heating characteristics of a nuclear explosion can be used to good advantage. As mentioned, one half of the total energy of the explosion may be retained in the formation as heat. This could be of great assistance in stimulating production from such reservoirs and affect a substantial increase in recovery.

Certainly the technologic and economic conditions will eliminate the application of nuclear explosives in many oil fields, but the application should be practical in many others having special characteristics. There must be several fields suitable for a test in this country and some of these undoubtedly are in remote enough areas to make a test practical. ★ ★ ★

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THE CENTURY AHEAD

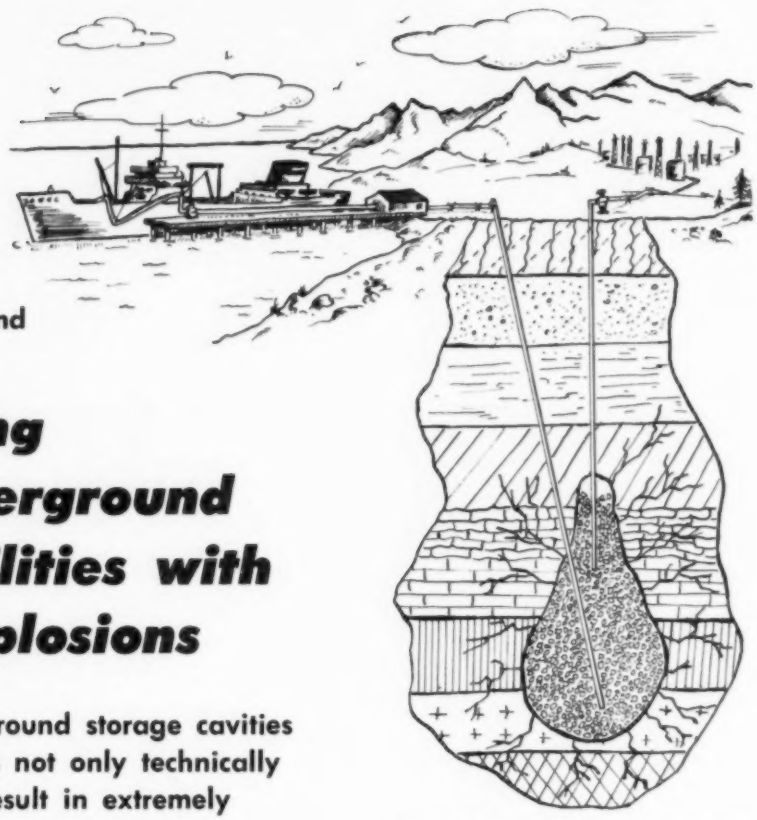

FIG. 1. Artist's conception of an underground oil storage facility constructed by nuclear explosives.

Economical Storage of Oil and Gas Promised by . . .

Constructing Underground Storage Facilities with Nuclear Explosions

Blasting out huge underground storage cavities for oil and gas storage is not only technically feasible, but could also result in extremely large monetary savings

Roland H. Carlson
Sandia Corporation
Albuquerque, New Mexico

THE ATOMIC ENERGY COMMISSION'S Project Plowshare is a program to investigate possible ways in which nuclear explosives can be used for peaceful purposes. Subject of this article — use of nuclear explosives in the construction of underground oil and gas storage tanks – is one of the Plowshare studies.

Engineers need hardly be told that in recent years the underground storage of petroleum and petroleum products has become increasingly popular. A few statistics will serve to show the extent of such storage. According to the National Petroleum Council, the amount of fuel stored underground increased from 7 million bbl in 1952 to 25 million bbl in 1956,[1] and projects are under way to expand this storage capacity still further.[2]

Although several types of underground storage are being developed, only the construction of caverns in impermeable rock is of interest from the point of view of using nuclear explosives. Total storage capacity of these caverns is at present about 1.5 million bbl.[1] Most of the caverns are used for storage of butane and propane; they range in capacity from some 260,000 bbl to 25,000 bbl.

Mention should be made of another possible application of nuclear explosives in the oil-storage field. It might be possible to construct open reservoirs and then cover them with floating steel roofs. Standard Oil Company of New Jersey has constructed such a reservoir for fuel oil in an abandoned open-pit slate quarry. This reservoir, which has a capacity of about 1 million bbl, was put in operation at a cost of $500,000. Oil is prevented from escaping by regulating the surrounding water table so that its hydrostatic head is always greater than that of the oil. The floating steel roof over the reservoir has an area of 1⅓ acres.

Obviously this interest in underground storage would not exist if the method were not both practical and economical. Major advantage is lower cost, even when construction is by conventional means. Propane and butane, for example, must sometimes be stored at pressures as high as 250 psi. Surface storage of these products sometimes costs up to $20 per bbl.[3] If propane and butane are stored in mined caverns, cost is between $2.80 and $5.40 per bbl.[1] Construction costs of aboveground and underground petroleum storage facilities are shown in Fig. 2, which is taken from Reference 1.

Cost, however, is not the only reason for the popularity of this type of storage. Among other important advantages may be mentioned:

1. No need for large quantities of steel in construction,
2. Stored materials relatively unaffected by changes in atmospheric temperature,
3. Lower maintenance and insurance costs,
4. Reduced likelihood of industrial accidents,
5. Inherent safety from military attack; easily hidden or camouflaged sites.

Granted, then, that underground storage is quite attractive, we have now to show: (1) That nuclear explosives could be used to create such facilities, and (2) that use of nuclear explosives would result in considerable savings.

Underground Nuclear Bursts

The kind of storage cavity that might be created by an underground nuclear detonation is shown in Fig. 1. Prac-

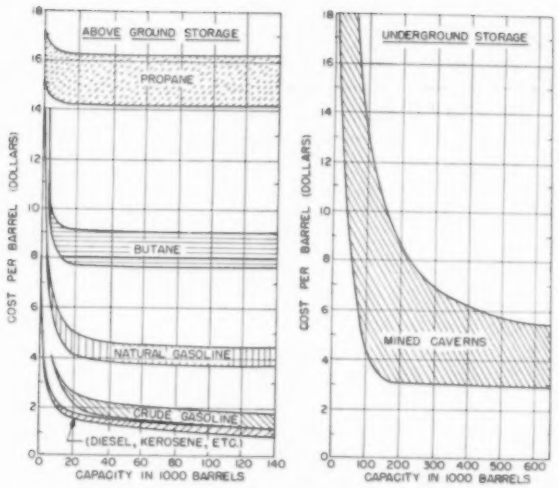

FIG. 2. Construction costs of aboveground and underground storage facilities are compared in these charts, taken from the 1956 Report of the National Petroleum Council.

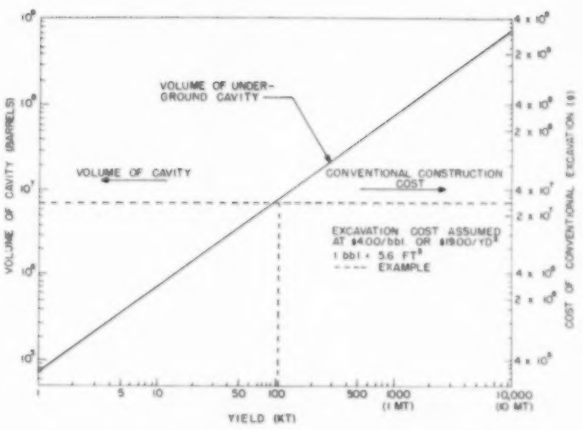

FIG. 3. Relationship between nuclear-explosive yields and volumes created, as well as cost of excavating equivalent volumes by conventional means, are shown on this scaling based on data from the Rainier test.

tically all of our information concerning underground bursts is at present derived from the Rainier shot of 1957, in which a 1.7-kiloton device was detonated in loosely cemented tuff.[4] In such explosions, the radius of the cavity produced is directly proportional to the cube root of the yield. That is, $R(ft) = KW^{1/3}$, where R is the radius of the cavity and W is the yield in kilotons. Again, the volume of the sphere (cubic feet) equal to the void created is 410 (10^3W) for the Rainier medium. From these formulas and other information we can extrapolate the relationship between explosive yield and the volume created for higher yields. Such a graph will be presented later. Finally, one other formula derived from Rainier data is of interest: Depth of burial (feet) necessary to ensure that the explosion will be completely contained underground is $450(W^{1/3})$.

Rock Medium

Type of rock in which the nuclear explosives would be placed is of great importance. Rock forming the ceiling of the initially-created cavity will, of course, collapse if the weight of the overburden exceeds its strength. Extent of the collapse depends upon type of rock; collapse continues until the existing span can carry the overburden through either beam or arch action. It turns out that the extrapolated cavity dimensions for large-yield nuclear explosions are so large that it is unlikely that any type of rock ceiling would remain intact at the depth required to contain the explosion. It should be noted, however, that even collapse to ground surface would not be completely detrimental; it might well be practical to cap the cavity and use it for oil or gas storage.

Since some degree of collapse seems inevitable, size of rock fragments that fall back into the cavity becomes important. If fragments are large, oil storage would be possible without removal of the rock. But if the fragments are small, capillary action and surface tensions would make it difficult or impossible to recover a large portion of the stored oil. In this event, it would be necessary to remove the rock. A television camera used to scan the cavity above the Rainier chimney showed fragments of boulder size. The Rainier medium, however, would almost certainly not be chosen for an oil-storage facility.

At present our evidence derives almost entirely from shots in tuff, and it is difficult to estimate effects such as cavity volumes in other media. An underground cavity is formed by compression of the medium or by an upward displacement of higher strata. Therefore, initial void space in the medium is probably a significant factor in determining size of cavity formed. Typical porosities are: Rainier tuff — 27 percent, granite—0.76 percent, and sandstone — 18.1 percent. It seems logical to assume that Rainier extrapolations give a fair estimate of cavity size for sandstone, while a cavity formed in granite would be much smaller.

One other observation concerning medium is appropriate. It is quite possible that criteria applicable to the selection of media for conventional construction techniques would not be applicable for nuclear construction. For example, a crushed zone impermeable to water would probably be created around the initially-formed cavity in some types of rock. Such a zone, for example, was discovered around the Rainier cavity. However, there are very little data on this subject, certainly not enough to act upon.

Radiation

Here, as in most applications of nuclear energy, close attention must be paid to the problem of radiation. Since the explosion would be contained underground, there would be no fallout or aboveground contamination. Underground, there would be a problem. In the Rainier shot, a major zone of radioactivity about 10 ft thick was formed along the bottom of the initially-created cavity. Hot spots in this region gave off more than 10^6 roentgens per hr immediately after the detonation and 137 roentgens per hr 146 days later. In an oil or gas storage application, it would not be practical to wait until the hot region had become safe through normal decay before using the cavity. Decontamination would

The Author

Roland H. Carlson *received his BS degree in civil engineering at Michigan State University in 1951 and his MS degree in structural engineering at the University of Illinois in 1953. During his tour of duty with the United States Air Force, his assignments included the Weapons Effects Division of the Research Directorate at Kirtland Air Force Base. From 1957 to the present he has been employed by the Sandia Corporation, where he has worked in the Nuclear Burst Department and participated in three full-scale nuclear test series. He has lately been occupied by work connected with Project Plowshare. He is a member of the American Society of Civil Engineers, The American Concrete Institute, and the professional fraternities Sigma Psi, Tau Beta Pi, and Chi Epsilon.*

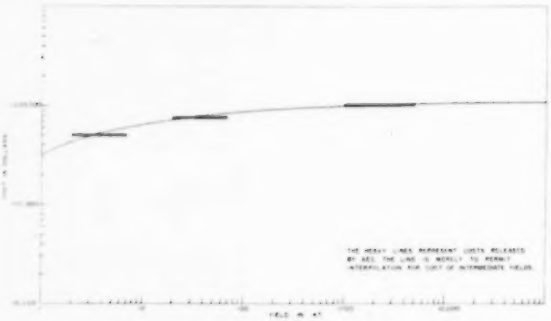

FIG. 4. AEC dollar charges for nuclear devices, based on costs released by AEC (heavy lines.)

NUCLEAR EXPLOSIVE YIELD	10 KT	100 KT	1 MT	10 MT
ESTIMATED COST OF NE AND PLACEMENT IN TUNNEL	$825,000	$1.25 x 10^6	$1.75 x 10^6	$2.0 x 10^6
VOLUME OF STORAGE CAVITY (bbl.)	700,000	7.0 x 10^6	70 x 10^6	700 x 10^6
COST FOR CONVENTIONAL EXCAVATION OF STORAGE CAVITY	2.8 x 10^6	28 x 10^6	280 x 10^6	2.8 x 10^9
ESTIMATED SAVINGS BY USING NUCLEAR EXPLOSIVES	1.9 x 10^6	26.7 x 10^6	278 x 10^6	2.7 x 10^9

FIG. 6. Estimated savings resulting from use of nuclear explosives of various yields.

therefore be required. Some possible methods of decontamination are:

1. A thorough flushing of the cavity with water under high pressure would make possible the controlled removal of a high percentage of the radioactive particles.
2. Oil might be stored in a contaminated cavity. When it was being removed from storage, it could be run through a mechanical filtering system to remove radioactive particles.
3. Contamination could remain in the oil. At the refinery it could be removed by disposing of asphalts remaining after distillation.

These are not necessarily recommended methods; perhaps other and better methods can be developed.

Temperature

Because of the flammability of petroleum and its products, attention must also be paid to the temperature of the cavity. Rainier data indicate that a medium with a high water content drops rapidly in temperature. (The Rainier tuff, with a water content of 15 to 20 percent by weight, dropped rather quickly from about 1300C to 100C.) A medium with low water content, granite for example, would probably retain high temperatures for a considerably longer time. All in all, this problem does not seem to be very serious. In practice, it would generally only be necessary — the fire and flash temperatures of the stored product being known — to measure the cavity temperature until a safe-entry time was reached. If the temperature were very high, or if saving time were very important, it might be possible to cool the cavity by feeding water into it.

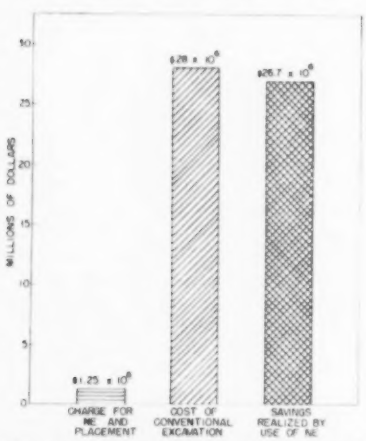

FIG. 5. Cost comparison of conventional and nuclear construction of a 7 million bbl underground storage cavity. Nuclear explosive used has a yield of 10 kilotons.

Placement of Explosion

To place the Rainier device in the rock, a tunnel was constructed. While this is certainly a feasible placement technique in some situations, equal consideration should probably be given to the possibility of placing the charge in a drilled hole. Holes 24 in. in diameter can be drilled to depths of 2000 ft with relative ease; holes 36 in. in diameter can be drilled to depths of at least 100 ft using a Calyx bit. A nuclear explosive yielding a few tens of kilotons would have a diameter of about 30 in.; one yielding a few megatons, 60 in.

Cost of Cavities

Fig. 3, a scaling of the Rainier data, shows the relationship between nuclear-explosive yields and volumes created, as well as the cost of excavating equivalent volumes by conventional means. Let us use a 100-kiloton nuclear explosive as an example. Fig. 3 shows that a 100-kt device is estimated to excavate a void of 7 million bbl or 1.5 cu yd of tuff. Estimated cost for excavating a mined cavern of equal volume would be $28 million. Consequently, savings realized by using nuclear devices equal the difference between the dollar charge for the device and its placement and the conventional excavation cost.

Fig. 4 shows in general terms the AEC charges for nuclear devices. For a 100-kt device, charge would be about $850,000. This amount includes the cost of the device, delivery, arming, firing, and safety measures during firing. It does not include cost of placing the explosive. Current estimates for drilling large-diameter holes indicate that placement costs for a 100-kt device should not exceed $400,000. Resulting savings would therefore be over $26 million (see Fig. 5). It is worth noting that savings of some $2.6 million would result even if our estimate for the volume excavated by the device were optimistic by a factor of 10.

To give some idea of comparable savings resulting from use of devices of different yields, Fig. 6 has been included.

Conclusion

It has not been our intent to present nuclear excavation as a panacea; our purpose has merely been to show that the method appears to be technically feasible and offers the possibility of very large savings in certain cases. Of course, the most practical method of constructing an oil or gas storage facility at a given site can be determined only by a careful evaluation of the unique requirements and circumstances of that site. Furthermore, it is apparent that a great deal of investigation is necessary before the method suggested can be put into actual operation. Nevertheless, after these qualifications have been made, the evidence suggests that the technique is promising enough to warrant further investigation and serious consideration. This application is but one of many examples of the ways in which nuclear explosives — the most powerful of known energy sources — can aid man in extending his control over his environment.

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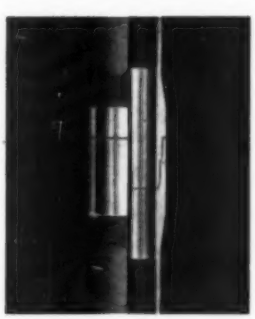

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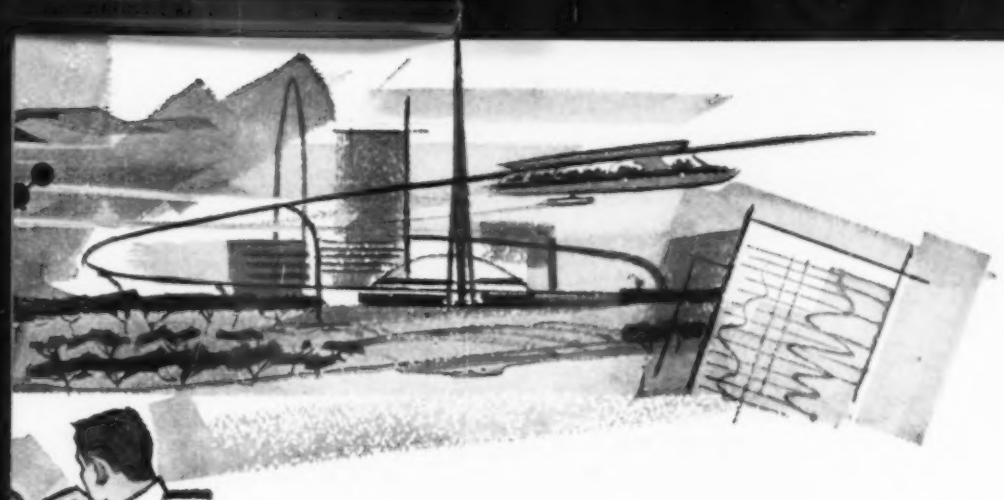

Accumulated energies of geologic time in the form of petroleum products have been released for man's use in one brief century. Many spectacular changes in the science of petroleum production have been born within the last twenty-five years. These amazing achievements justify extravagant speculations as to the direction of discovery, evaluation and recovery techniques in the next 100 years.

It was only twenty-six years ago that Lane-Wells opened up an entire well completion technology with the first practical gun perforating service. With that event was born a giant service industry whose progress has been rapid and steady. Only last year Lane-Wells made available test results from their new Flo Lab to provide consistent data for perforator evaluation and improved equipment design. From such facilities important refinements, even sweeping new technologies, are already on the way.

Few men in the industry could have foreseen twenty years ago the far-reaching effects of Nuclear Logging. Thus Lane-Wells first provided oil men with the means to look through the casing for stratigraphic data that could be obtained in no other way. Many productive zones would have remained untapped had it not been for this development.

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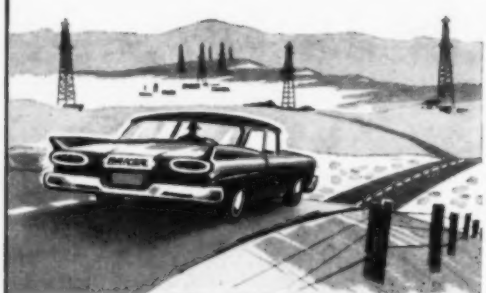

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SEEP-SNIFFERS AT SEA

Boat-borne infrared analyzers probe U. S. and foreign waters in low-cost methane-seep searching operations

AN ELECTRONIC BLOODHOUND is the key element in a new offshore petroleum prospecting technique perfected by The Atlantic Refining Company.

The "bloodhound" is a boat-borne infrared analyzer which detects methane gas in the water, pinpointing the location of hydrocarbon seeps from beneath the sea or ocean floor.

To date, the company has successfully surveyed millions of acres of U. S. coastal and foreign waters. One foreign survey alone covered more than 4,000,000 acres.

Low Cost

Seep finding by boat is an extremely fast exploratory method, and a very economical one. Survey speed is limited only by the speed of the vessel. Since the analyzing equipment takes up no more space than an average size office desk, small boats can be used for surveys in protected waters. Atlantic has conducted surveys from a 22-ft outboard-powered barge, a 65-ft seagoing crewboat and a small tramp freighter. The larger boats for open sea surveys range out to 30 miles from the shore.

The cost of seep-searching compares favorably with the cost of airborne magnetometer surveys, but is much lower than the cost of the often-used seismic reconnaissance technique.

Gas Analyzer

How does the electronic "bloodhound" detect methane seeps?

The instrument used is the same nondispersive infrared analyzer employed in many industrial plants to detect gas leaks and to determine concentration of gases. For Atlantic's surveys, the analyzer was calibrated specifically to detect methane.

The reference gas in the detector reference cell and sample gas in the sample cell absorb unequal amounts of infrared radiation, causing unequal pressure on the sides of the detector and a diaphragm-condenser. The imbalance between reference and sample absorption and pressure causes a change in the signal transmitted to the recorder pen.

On the seep survey boat, a continuous stream of water is pumped aboard, and dissolved air and gas is separated from the water, dried and analyzed automatically by the instrument. Results are recorded continuously on a strip chart.

Survey Course

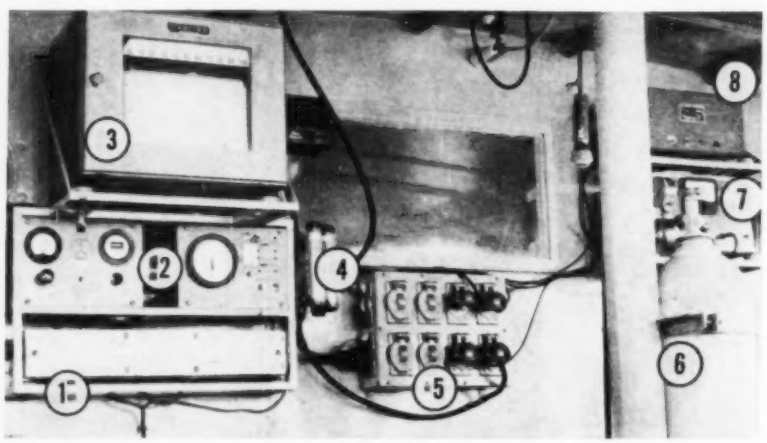
The survey boat follows a zig-zag course to compensate for currents which might carry the methane gas away from the actual seep. The course is pre-plotted and generally moves in an upstream direction. The infrared analyzer can detect seeps leaking as little as 0.5 cu ft per hr — even in strong currents.

Once the exact location of the seep is found, the only problem remaining for the survey team is to fix the spot on a map so that the boat can return to seep again. Atlantic officials do not accept the existence of a seep, unless methane can be detected at the same location again at least a week later.

Radar Plot

Since survey boats use navigational radar, it is relatively easy to plot the exact location of seeps on the map. The boat is always represented as the exact center of the radar screen so, by placing a transparent overlay map on the screen, the survey team can plot the exact site of the seep in relation to the shoreline on the map.

The data obtained from seep location maps is important to Atlantic in two ways: The company can tell which submerged areas are likely to yield oil and which areas are not worth additional exploration. ★ ★ ★



Nose of Atlantic's seep-sniffing "bloodhound" is shown here. Components of the instrument include: (1) Infrared analyzer, (2) flow control, (3) strip chart recorder, (4) gas driers, (5) switch box, (6) calibration gas bottle, (7) amplifier, and (8) voltage regulator.

Two of the three vessels used in the methane seep finding operations. The **Phydeaux**, a 22-ft outboard barge, is moored alongside the **Solitude**, supply boat for the sniffer team.

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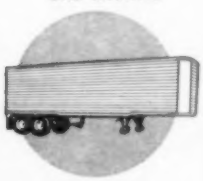

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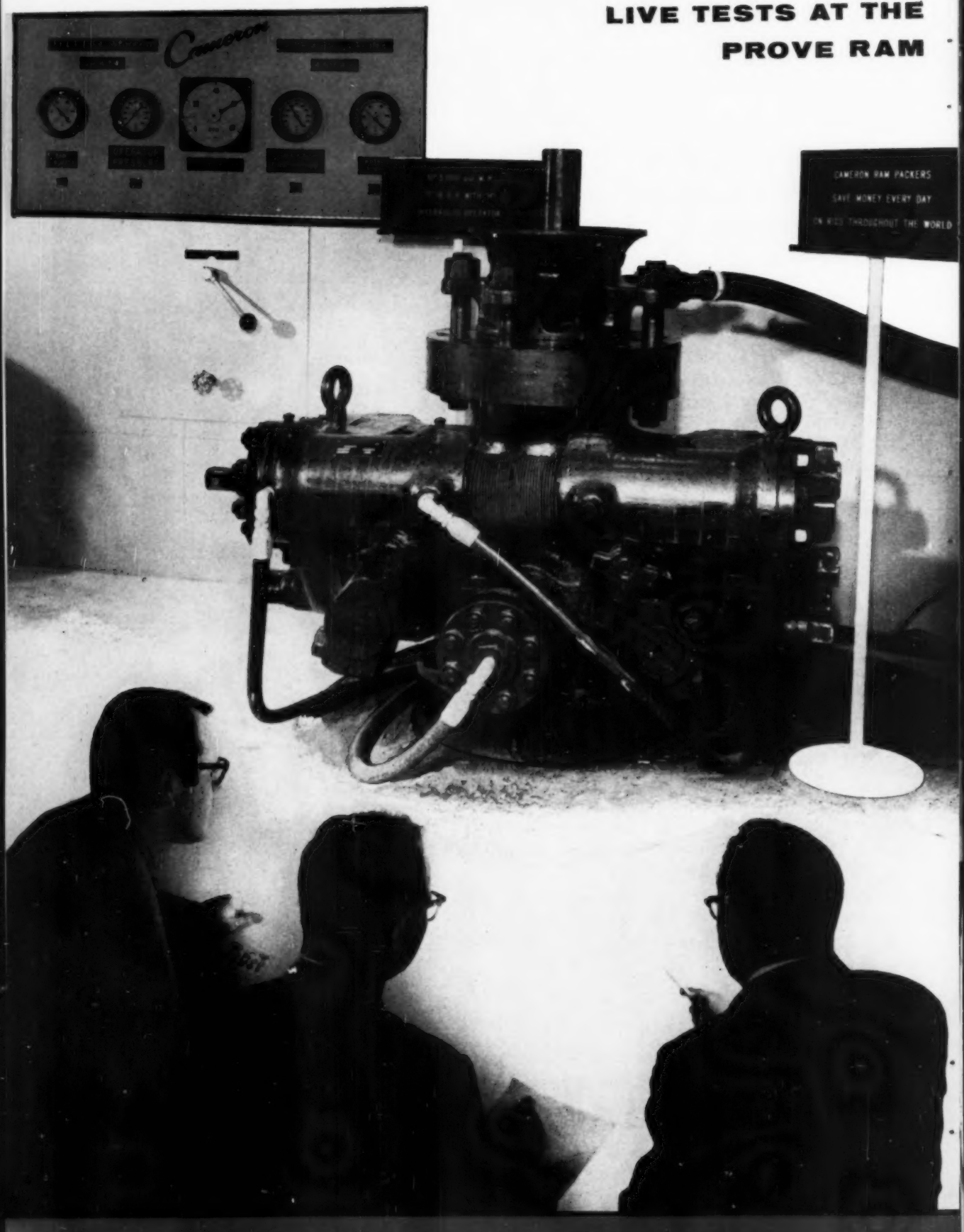
LIVE TESTS AT THE PROVE RAM



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TOTAL VERTICAL PIPE TRAVEL — 4,877′

TOTAL NUMBER PIPE REVOLUTIONS — 45,792

Well pressure — 2,000 PSI

— and only 60% of the feedable rubber reserve was used.

Drill pipe size — 3½″

Vertical velocity — 6′ per minute

Rotating speed — 66 RPM

In Cameron's patented ram design the sealing rubber is always fully confined by steel.

BEFORE

AFTER

4,877 feet of 3½″ drill pipe rotating at 66 RPM was run through this ram element while it held 2,000 PSI pressure — and only 60% of feedable rubber reserve was used.

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Santa Rita No. 1:

Where Oil in West Texas Began

The "impossible" well at Big Lake opened a new era in oil industry

David L. Black
Austin, Texas

SANTA RITA NO. 1, the first producer on University of Texas oil lands, now stands as a memorial on the university campus in Austin. This well marked a change in revenues for the university and a change in the economy of West Texas.

When Frank T. Pickrell, El Paso businessman, gambled on the possibility of oil in West Texas, university lands were being leased for grazing for 5 or 10 cents an acre.

R. P. Ricker, a West Texas rancher, blocked up 31,360 acres of university lands in Reagan, Irion, Upton and Crockett counties. He joined Pickrell in the move to explore the area for oil by organizing the Texon Oil and Land Company.

The struggle to interest investors in the project was hard. Pickrell filed drilling permits in Austin, traveled back and forth between New York and Texas, where he sold certificates of interest in the project. To complicate his difficulties, time was running out on the drilling permits. If drilling did not begin soon, the permits, which cost $43,000 would expire.

Saint of the Impossible

Pickrell finally interested a group of Catholic investors in his venture. They sought the advice of a priest, who advised them to ask the aid of Santa Rita, Saint of the Impossible. Before Pickrell left New York, he was given a sealed envelope containing a red rose by two Catholic women. They instructed him to climb to the crown block of the derrick, crumple the rose and let the petals drift over the structure. He was to say at that time, "I christen thee Santa Rita." He followed their instructions.

According to one account, Pickrell was in New York when he learned that his permits would expire on the eighth of the month. He hurried back to Texas, located a water drilling machine 40 miles north of San Angelo, and had it shipped by train to the town of Best, in Reagan County. When it arrived, the crew had five hours of grace before the permit expired. In their hurry to unload the rig from the flatcar, they let it fall, which damaged it slightly. It is said that the original well, necessary to validate the lease, was drilled near the tracks where the rig was damaged. Some say the hole drilled there was a water well and that the real Santa Rita oil well was drilled on another location.

The wooden rig for the Santa Rita was completed in July of 1921. Pickrell then hired Carl G. Cromwell of Cisco as his driller. His instructions were to drill to oil or gas, or until he reached a total depth of 4000 ft. The Santa Rita was begun in earnest on August 17, 1921.

For the next 20 months, Cromwell and his wife and daughter lived on the lease. It was nearly impossible to get a helper to stay very long on the location, for the nearest town was San Angelo, 90 miles away.

Show of Oil

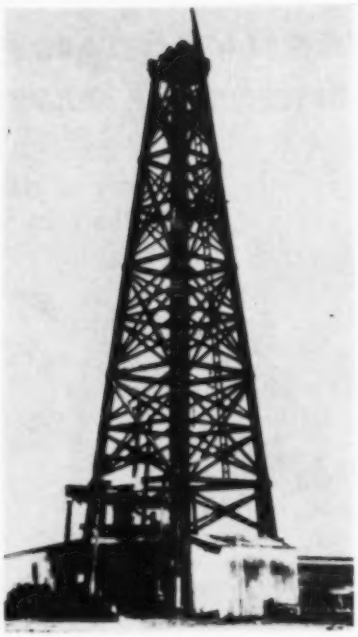
On Sunday, May 27, 1923, Cromwell discovered a small show of oil at a depth of 3055 ft. Running the bailer in once more, it came up full of oil. He nailed boards around the derrick to keep out strangers, and closed down the well until the following day.

Early the next morning, Mrs. Cromwell was cooking breakfast when she heard a strange noise outside. Going to the door, the family saw a cloud of gas and oil vapor rising above the derrick.

The well headed three times that day, twice the next, and then settled down to a 100 bbl a day flow.

Cromwell wired Pickrell who was drilling in Arkansas. When he arrived, he found he had a producer in the middle of 64 miles of leases.

Plaque, located near the reconstructed rig, tells the story of historic well.



"Saint of the Impossible" gets the credit for finding oil in the middle of a 360,000 block of land in West Texas sage brush country.

Beginning of a New Story

The Santa Rita was the beginning of the development of the Permian Basin. Today, the university has over $300,000,000 in the Permanent Fund from the oil lands of West Texas.

The reconstructed rig now stands in a fenced enclosure on the campus in Austin, surrounded by cactus from West Texas. An inscription on a plaque reads:

> "Santa Rita No. 1 was the first producing oil well on Permanent University Fund lands. On Monday morning, May 28, 1923, it blew in to launch a new era in the development of the University of Texas and the Agricultural and Mechanical College of Texas. Located on the Ollie Parker ranch in Reagan County, the well was named by its drillers for Santa Rita, the Saint of the Impossible, because of popular opinion that there was no chance of success in this location." ★ ★ ★

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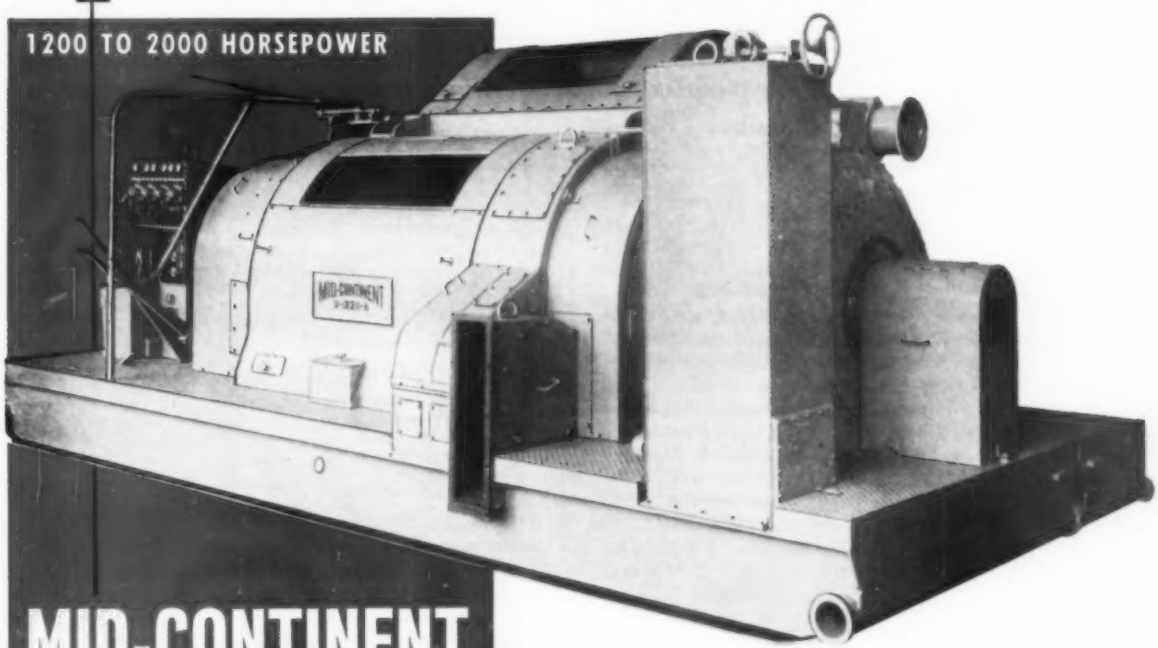

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- **DOUBLE ADJUSTMENT MAIN BRAKES** are fully equalized with 60" by 10¾" water circulating rims of roll forged alloy steel.
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Gas Condensate Reservoirs

***Part 4** of a new fundamental series on gas-condensate reservoirs presents gathering system and field processing costs and two-phase flow conditions*

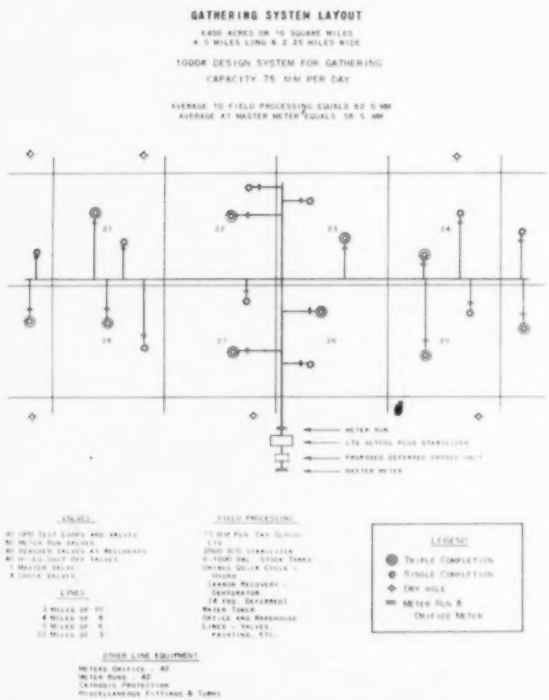
William C. Goodson
Republic Natural Gas Company
Dallas, Texas

Gathering System and Field Processing

The gathering system and field processing should be considered with care. The responsibility for installations of this type usually fall in the bailiwick of the Gas or Production Department of most companies.

A knowledge of contract commitments, gas properties and reserves are necessary to the process and gathering system design. The well locations, plant location, measurement facilities, hydrate possibilities all need to be studied. A graphic picture of the well layouts, lines, volumes to be handled should be sketched as an initial step.

From this graphic map (1) the lines can be sized, (2) the number and locations of necessary orifice meters and valves can be determined, (3) optimum or centralized location for processing equipment can be determined, (4) right-of-way negotiations can be initiated with the land department, (5) tie-in points to transmission line can be decided upon, (6) possibilities for gasoline plant site can be studied, (7) and the many contingency factors, can be evaluated.



Gathering system and field processing costs are developed for this typical gathering system in the AFE.

AFE Field Gathering System and Field Processing.

Item	Amount	Cost Per Unit	Total Cost
A. Lines	158 in.-miles	$3240/installed/in.-mile	$ 512,000
B. Valves	205	Varying	84,000
C. Other line equipment			
Meters	42	625	26,000
Meter runs	42	Varying	17,000
Cathodic protection	—	—	8,000
Fittings and turns	—	—	40,000
D. Field processing			550,000
E. Contract for installation			185,000
(Approximately 15% of items A-D)			
F. Supervision and contingencies			148,000
(Approximately 10% of A-E; this includes right of way, etc.)			
Total			$1,570,000

A simple flow diagram of the system in this study and an AFE (authority for expenditure) of the entire system will serve to point out many of the variables.

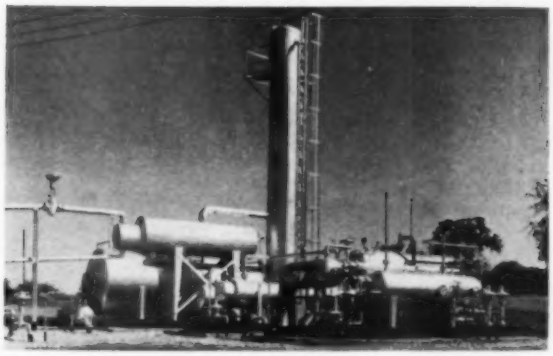
Each triple well will be connected with:

1. Reacher valves for each zone,
2. Flowlines 3 in. in size,
3. Separate meter runs — meters and valves for each zone,
4. GPM test loops for each zone,
5. High-Lo shutdown equipment for each zone.

The 10 single completion wells will be completed or tied in as above with one piece of each equipment. The arteries will be equipped with cathodic protection and one master orifice meter will be put on the 10 in. line after all wells have been tied in.

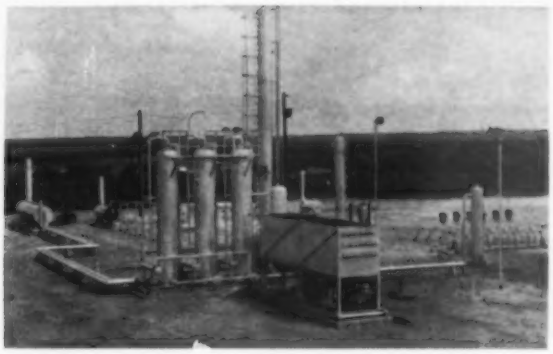
As discussed in the section on recoverable gas reserves, a large centralized Glycol LTS unit with stabilization will be placed in the system. This unit should be sized to handle approximately 75 MMscf per day. Sufficient storage should be set up to handle 5 days condensate production under normal conditions. Provisions should be considered for future dehydration when the pressure has dropped. A large Quick-Cycle dry bed unit would probably be best for this type installation. The field office should handle all paper work pertinent to production and allocation of products back to the individual wells and zones.

For the Intrastate Contract to deplete the reserve in 10 years a gathering system essentially the same as given



Glycol low temperature system located on the initial deep gas condensate production in Oklahoma. This is a 10 MMscf-per-day unit handling extremely rich gas. Units of this type with stabilization are highly desirable in high-pressure gas condensate reservoirs.

Photo courtesy National Tank Company



Three-tower dry-bed quick-cycle hydrocarbon recovery unit allows rapid cycles in each dehydration tower and greater hydrocarbon recovery than the more conventional two-tower units. This unit is owned and operated by Elms and Eckert and is handling gas from several wells. Units of this type are capable of recovering up to 70 percent of the inlet C_5 + content.

Photo courtesy Parkersburg Rig and Reel Company

above but approximately double in capacity will be required. Since in all aspects but size the systems are similar, a quick estimate of the cost can be obtained by multiplying the cost of the interstate system by the ratio of the intrastate system size to the 0.6 power

$$\text{Cost-Intrastate} = (\$1{,}570{,}000)\frac{(140\ \text{MMPD})^{0.6}}{(\ 75\ \text{MMPD})} =$$

$$(1{,}570{,}000)\ (1.85)^{0.6}$$

$$= (\$1{,}570{,}000)\,(1.453) =$$

$$\$2{,}280{,}000$$

At a recent regional NGAA meeting in Amarillo a panel discussion of field separation was held with engineers from four of the leading manufacturers participating. This discussion covered four of the more prominent methods of field separations and covered the advantages and disadvantages of each from both a mechanical and processing standpoint. The methods covered were:

1. Low temperature separation;
2. Quick-cycle adsorption with open regeneration;
3. Quick-cycle adsorption with closed regeneration;
4. Absorption (ammonia) refrigeration.

This discussion was presented in the *Oil and Gas Journal*, February 9, 1959, and is recommended to both those who are familiar with field processing and to those who are totally unfamiliar with the idea.

The actual evaluation of liquid recovery by either of the quick-cycle processes is not as simple to evaluate quantitatively as the evaluation of recovery by low temperature or refrigeration methods. The method and processing involved is more complex than the equilibrium relationships that apply to the more conventional separation methods.

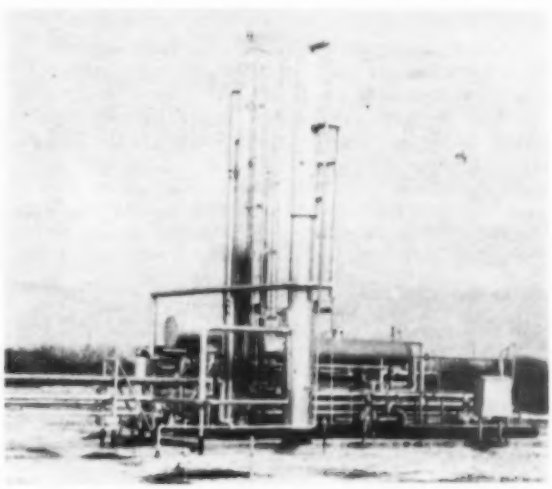
For purposes of this paper, the additional recovery by the deferred installation of a quick-cycle dry bed unit will be considered as lagniappe and will be ignored. In actuality these units in test situations have recovered from 40 to 100 percent of the iso-pentanes plus content of the inlet gas stream. With as much activity and research as is currently being done on this topic, suitable parameters should soon evolve that will allow as accurate and rapid an evaluation of adsorption processes as is now possible in the flash vaporization processes.

Two Phase Flow Conditions

The consideration of both liquid and gaseous phases flowing simultaneously in pipelines is becoming more and more a problem of serious magnitude in the design of both gathering systems and major transmission lines. Ovid Baker of Magnolia Petroleum Company has devoted a tremendous amount of work and study to this problem. He and other researchers have developed many useful correlations for the empirical solution of this problem. In a paper given before the American Gas Association entitled "Some Design Suggestions for Multiphase Flow in Pipelines" in May 1958, Baker gives considerations of the magnitude of this problem and make a plea for more and better data particularly for lines larger than 10 in. in diameter.

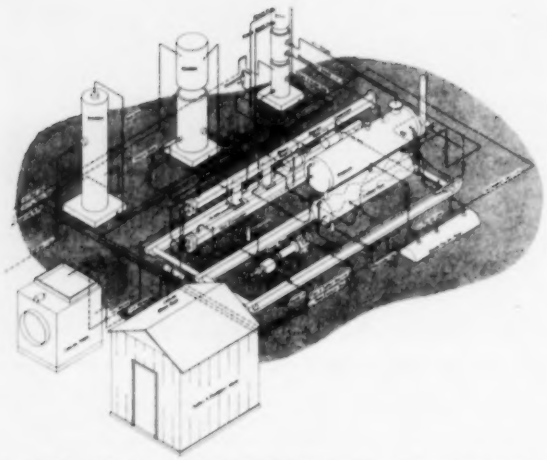
This problem is of concern in the gas condensate fields in south Louisiana and the remote regions of Canada in that the stream is usually separated and metered at the lease or wellhead and then commingled as a two-phase stream and transported to a more accessible central separation unit or processing plant.

Some idea of the seriousness of this problem and the need for further study and organization of the data can be gotten



Ammonia absorption refrigeration with LTS facilities located in South Texas was designed to process 5.0 MMscf per day at 1000 psig and O F. Unit currently handles 2.2 MMscf per day and recovers 11.9 bbl per MMscf of stock tank liquid from a casinghead gas system. Pertinent features of the unit are the horizontal gas chiller (upper background), horizontal ammonia absorber (in front of chiller), vertical ammonia still column (background), cold feed stabilizer (foreground). This type unit has its primary application on casinghead gas systems and on condensate streams where natural gas expansion is not sufficient for refrigeration.

Photo courtesy Black, Sivalls & Bryson, Inc.



Lease desulfurizer designed to deliver specification sweet gas after removing the H_2S by contacting the sour gas with counter-current circulation of amine solution in the packed absorption column. Units of this type are designed for moderately sour gas streams where sulfur recovery is not feasible.

from considering that over $500,000,000 has already been spent on lines transporting two-phase flow and that, in designing initially for two-phase flow, some engineers have found that the pressure drop will be as high as 10 times that of single-phase flow.

Some of the factors that Baker gave in his talk that affect the liquid hold up in pipelines are:

1. Gas phase in turbulent or streamline flow,
2. Liquid phase in turbulent or streamline flow,
3. Angle of the pipe with the horizontal,
4. The absolute pressure of the gas and oil,
5. Roughness of the pipe,
6. Heating or cooling of the pipeline,
7. Pipe diameter,
8. Flow pattern,
9. Hilly condition of the terrain.

No attempt will be made here to do anymore than discuss this problem in a qualitative descriptive manner. For the readers who are faced with this problem from a design standpoint, the paper by Baker given at the American Gas Association or others given by him before the NGAA, AIME and API are recommended as excellent for this work. It must be emphasized that this is not a static type of problem but one that varies with each flow condition. Tremendous savings in both time, investment, and steel pipe can be effected by proper consideration of all the variables in two-phase flow.

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(In order to facilitate further investigation of the subject, references used in the preparation of this series of articles are listed herein. Additional references developed in future installments will be included with the concluding article of the series.)

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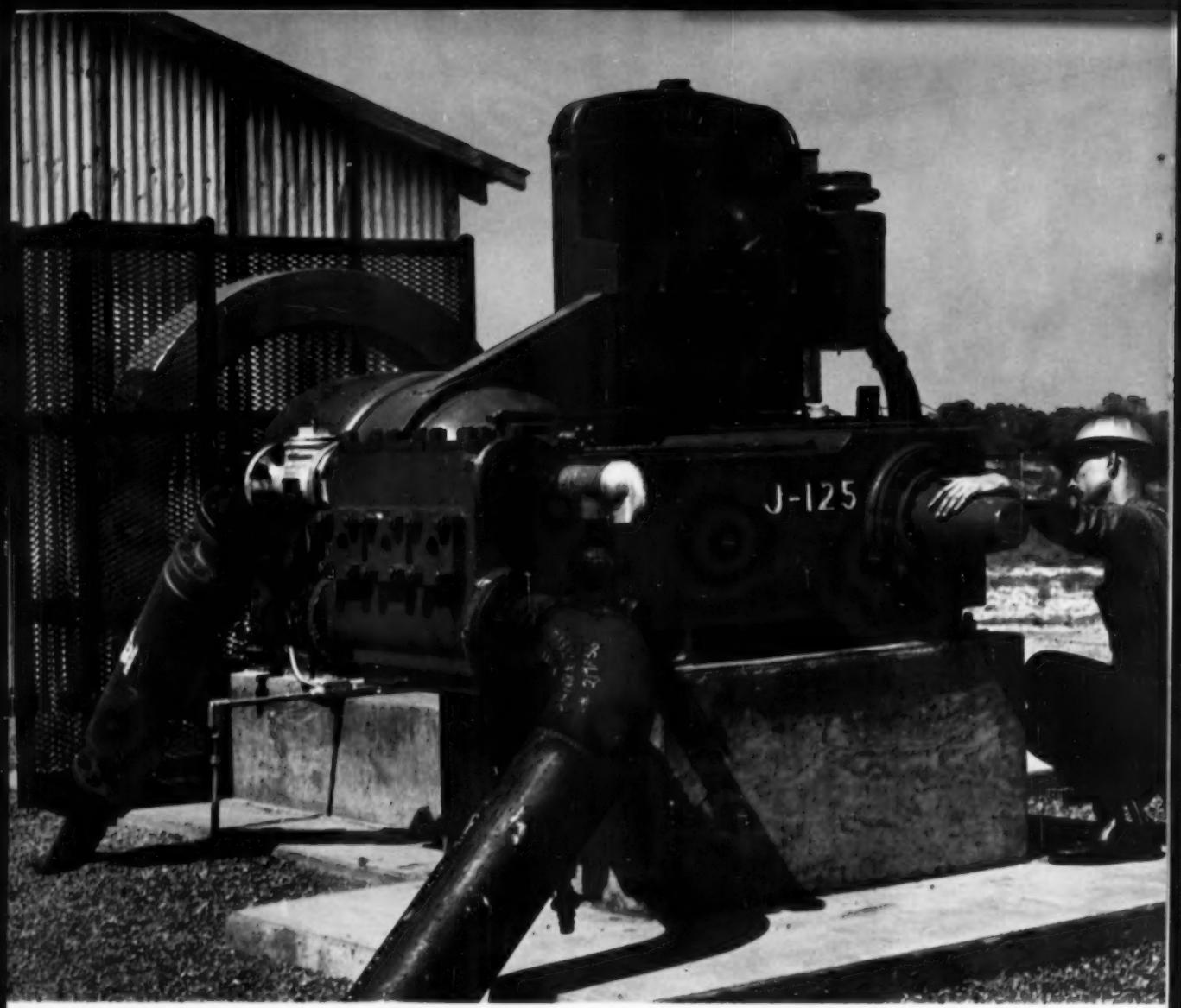

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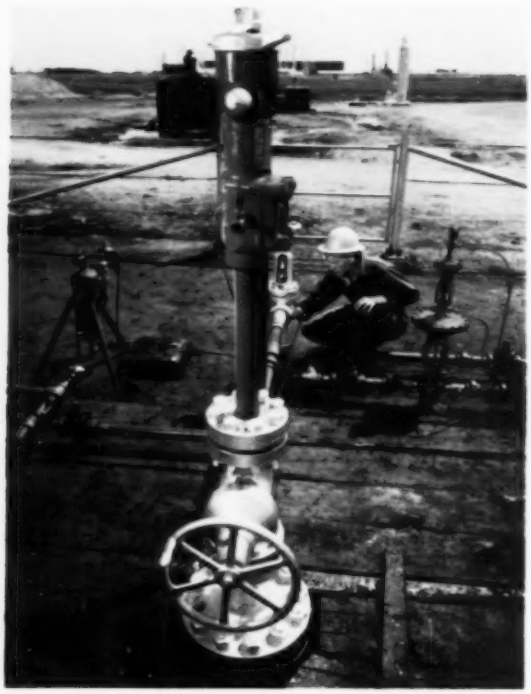

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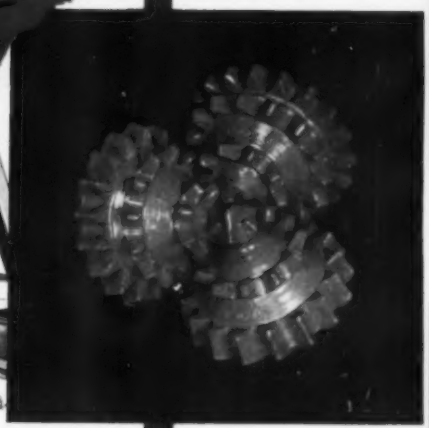

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THE ATLANTIC LECTURES OF THE UNIVERSITY OF TEXAS

PART 10

What is Miscible Displacement?

The injection of hydrocarbon miscible fluids is fast taking its place along with waterflooding as a major injection process for increasing oil recovery

W. F. Kieschnick, Jr. *Asst. to General Manager of Exploration, Atlantic Refining Company, Dallas, Texas*

WHAT IS MISCIBLE DISPLACEMENT? You might say it is high pressure gas injection, the propane slug process, condensing gas drive, vaporizing gas drive, the gas propelled solvent drive, and others, with and without modifying features such as water injection. As a matter of fact, it is more properly identified as the concept back of a multi-million dollar industry effort to recover more oil. Miscible displacement of oil from a reservoir has evolved from high pressure miscible displacement by gas almost a decade ago to the present array of related processes which are collectively applicable to a wide range of reservoir situations. Although not a panacea, this general approach is now well on its way to becoming an established method, taking its place along with waterflooding as a major injection process for increasing oil recovery.

Basic Ideas About Miscibiltiy

Miscibility is defined: "The ability of two or more substances to mix and to form a single homogeneous phase." Gasoline and oil are miscible. Water and ethyl alcohol are miscible. In contrast, water and gasoline are immiscible. Water and grease are immiscible.

The usefulness of *miscibility* in reservoir displacements will be more apparent if we understand the implications of *immiscible* conditions, conditions involving interfaces. Fig. 1 illustrates a pore doublet,[1] a simplified model of two pores through which there is parallel flow. This is not physically exactly like reservoir pores, but it illustrates the type of flow occurring in porous rocks. Since the porous rock

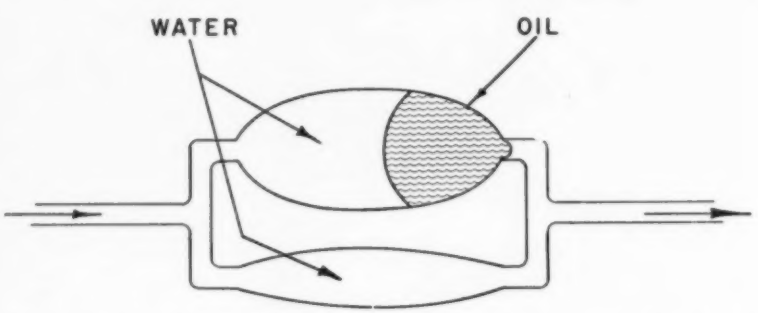


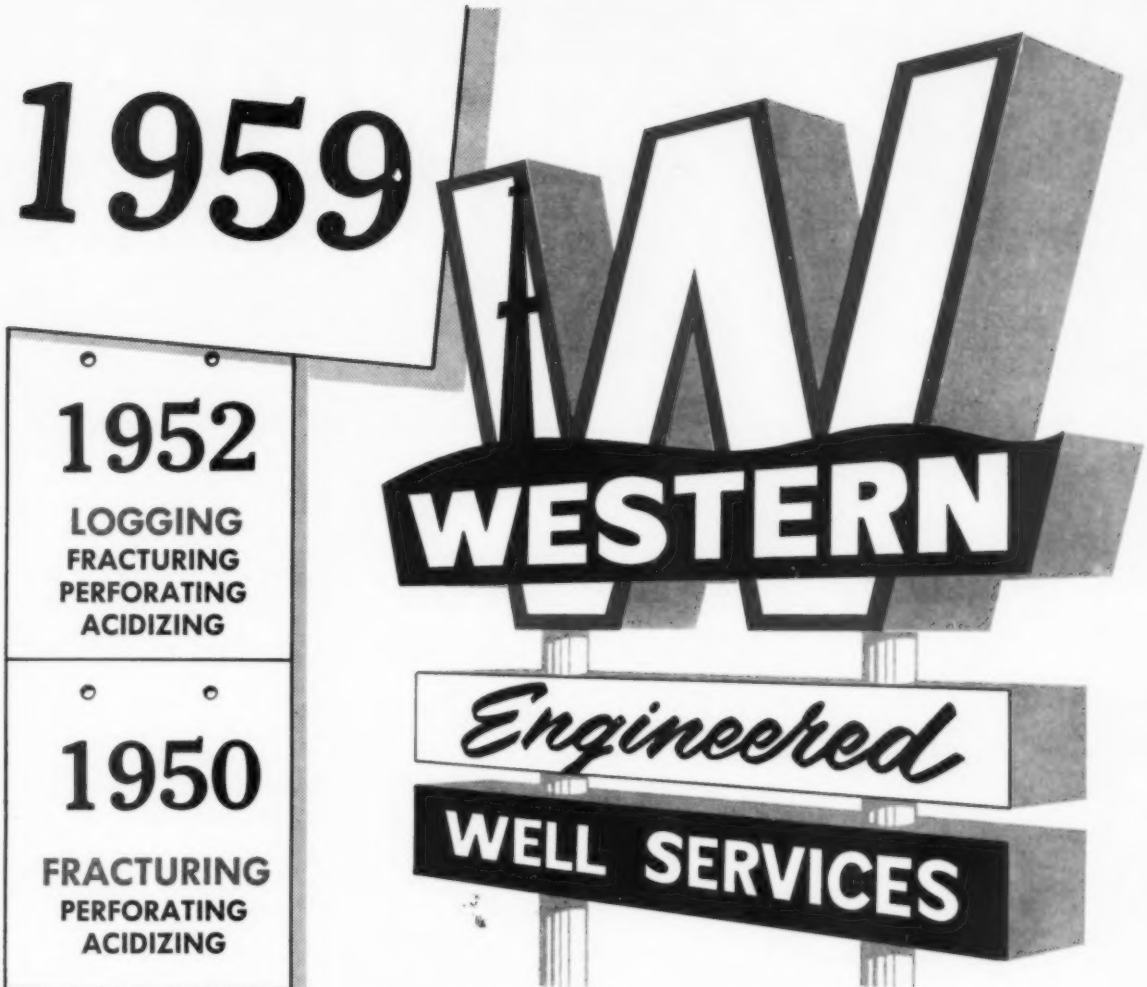
FIG. 1. Pore doublet model illustrates the effect of capillary forces on the flow of water and oil through a pore space.

in this example is wet by water and since the two pores compete for a limited supply of water flowing through a constriction, the capillary forces "draw" the water faster through the small bottom pore than through the upper larger pore. Therefore, some oil is left in the larger pore by the time that the small pore is completely flushed of oil by water.

This oil droplet is trapped and capillary forces won't move the droplet because the oil-water interface must flow through a smaller diameter pore at the downstream end than at the upstream end. Therefore, there is a greater capillary pressure resisting entry of oil into the small channel than there is capillary pressure aiding the entry of water on the other side of the pore. Ordinarily the viscous pressure drops are so small over these short distances that they cannot usefully aid in dislodging the oil droplet. This is basically why residual oil is left behind by water displacement.

If there were no interfaces between the fluids and if both fluids were enough alike to have about the same fluid-to-rock surface relationships, the oil would not be trapped. Indeed, it would be washed out by the solvent described by the above features.

A fundamental prerequisite for miscibility between two liquids is that they be somewhat alike chemically. Kerosine and gasoline, which are miscible, are both hydrocarbons; and the molecules of each of these two substances are actually much alike. This brings up the idea of obtaining miscible displacement between two unlike fluids by finding a third fluid with intermediate properties. This intermediate fluid can be close enough in properties to each of the other fluids so that under some conditions miscible displacement can occur at both fronts. In most miscible



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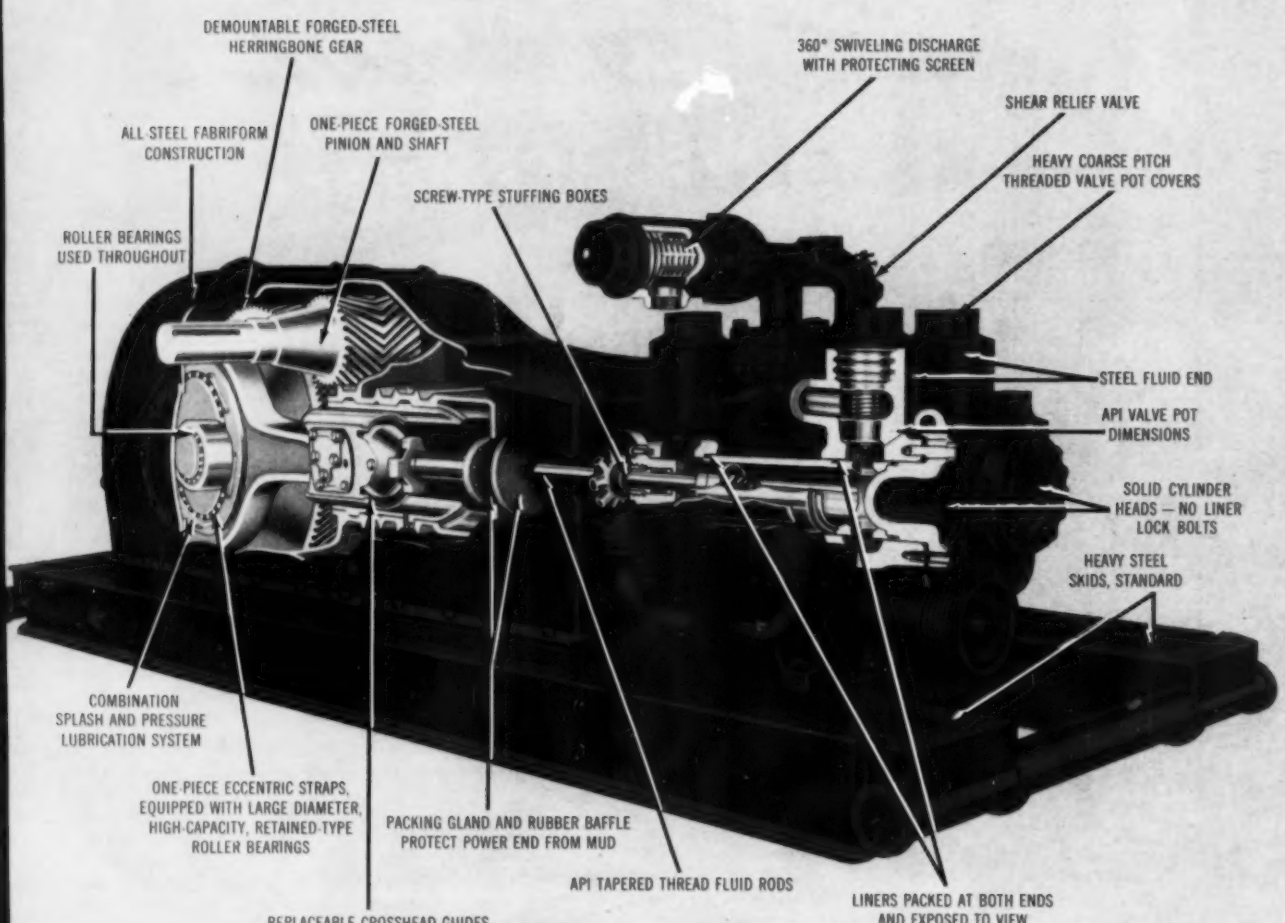
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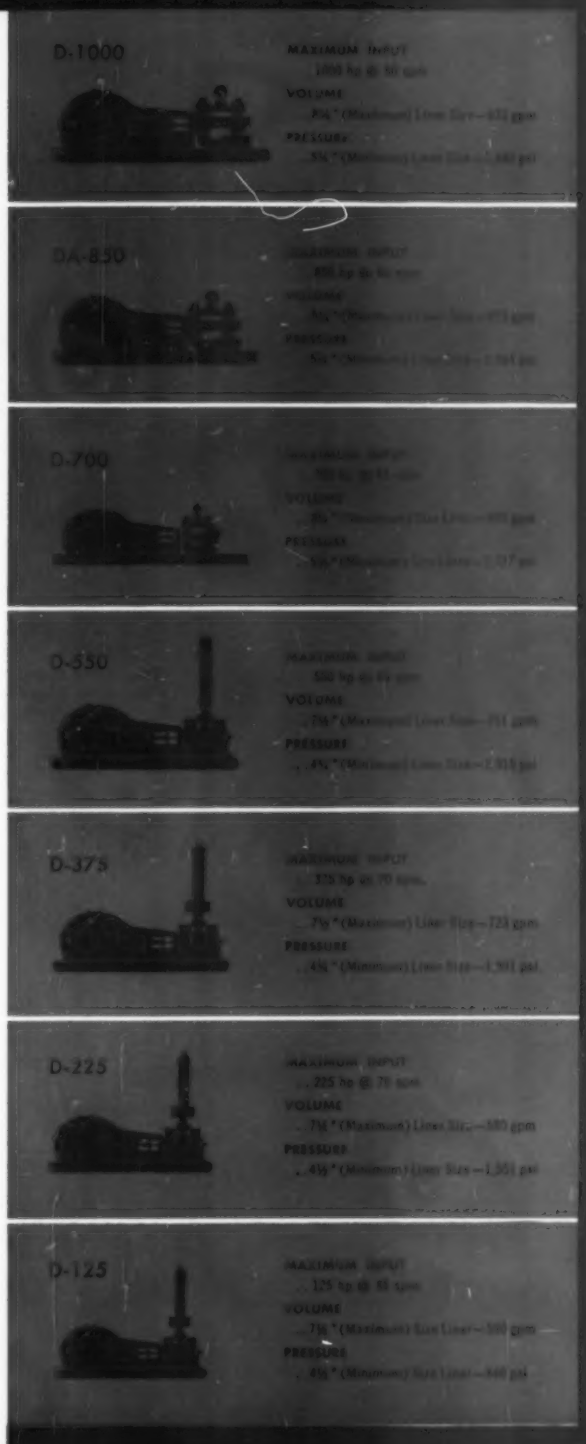

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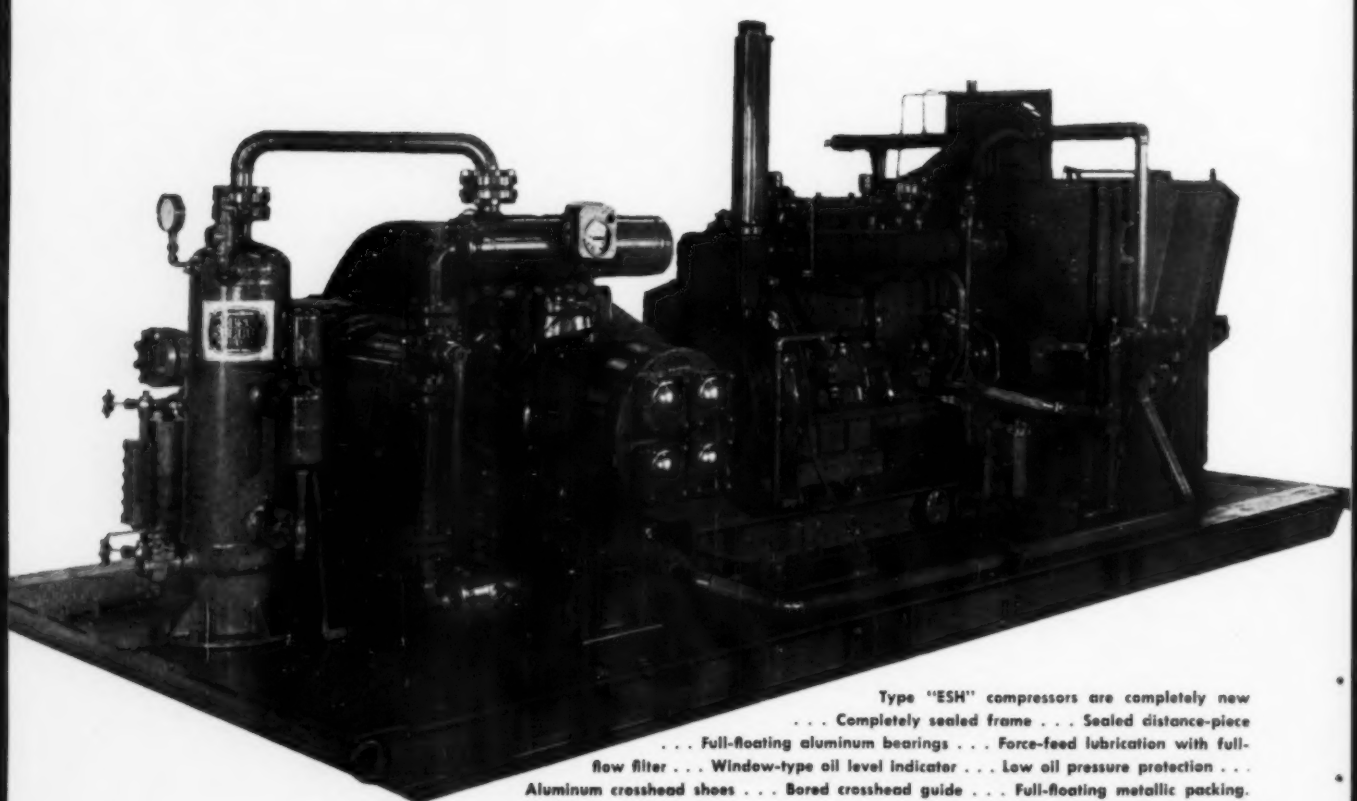

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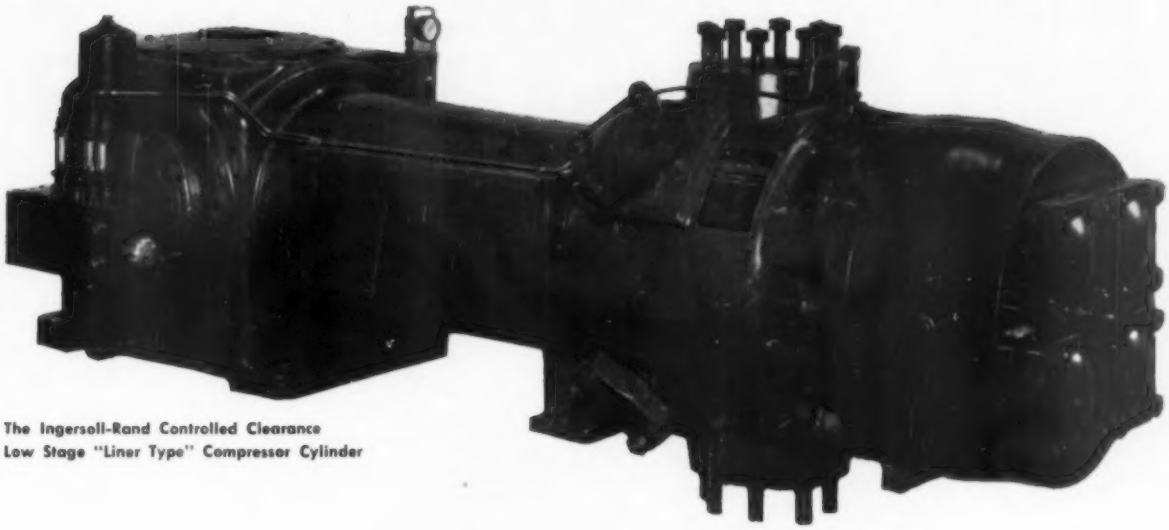

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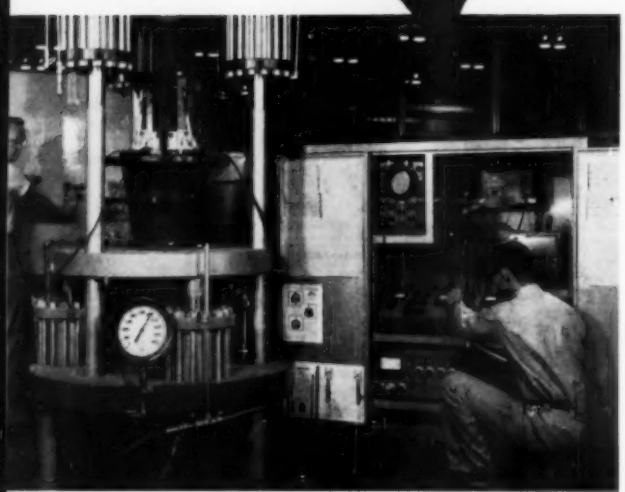

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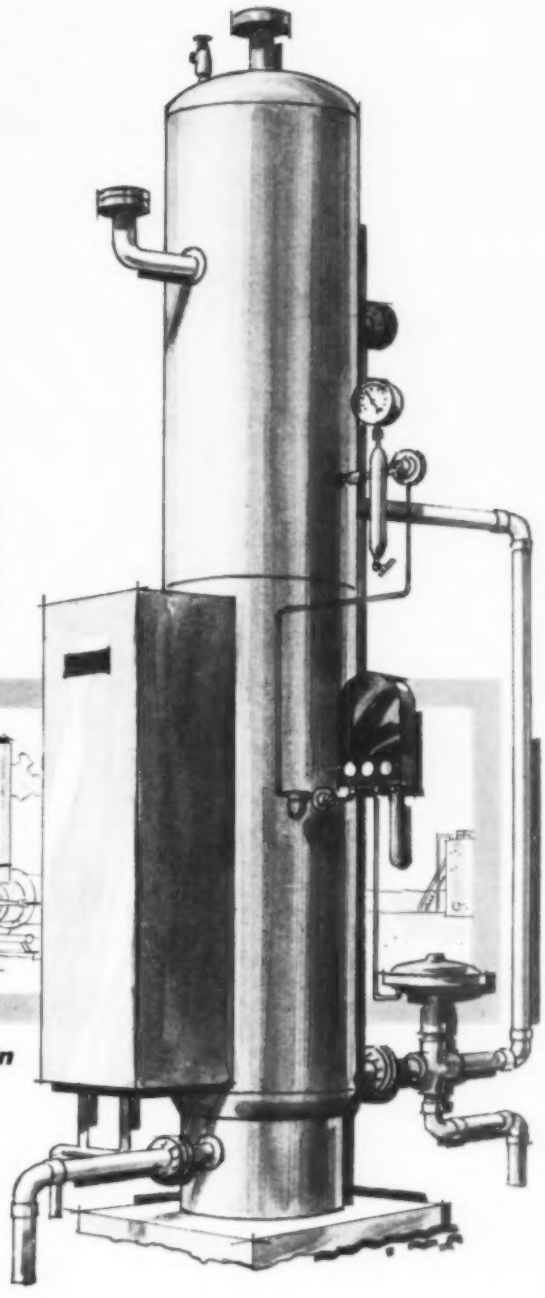

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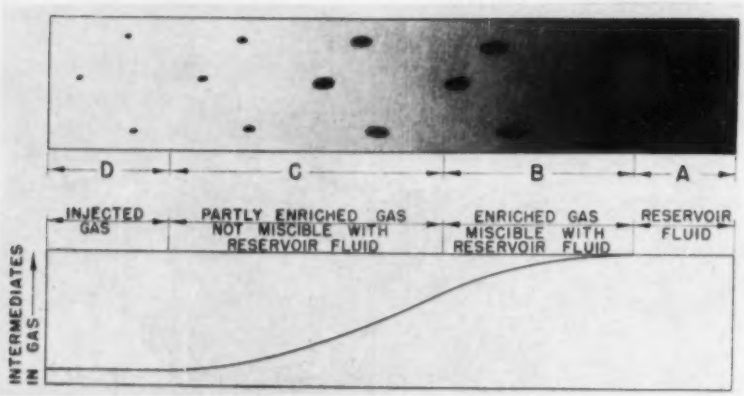

FIG. 2. Schematic representation of high pressure gas displacement illustrates intermediate enriched zone progressing through the reservoir. Relative amounts of intermediates (LPG and natural gasoline) in the various phases are shown on the lower graph.

displacement processes, natural gas is injected as a displacing agent. Natural gas is not miscible with reservoir oil completely in many situations, so we need an intermediate compound. It turns out that LPG, propane or butane, is usually the most reasonable intermediate material to use for this purpose.

High Pressure Gas Process

All hydrocarbon miscible displacement processes require the presence of a band of intermediates between natural gas and reservoir oil. In the high pressure gas process,[2,3] the intermediates come from the reservoir oil. High pressure natural gas is injected into a reservoir under conditions which are appropriate for the buildup of LPG and natural gasoline at the front to form a zone of intermediate compounds between the gas and the oil. Even though natural gas is not completely miscible with reservoir oil at the pressure at which we carry out this process, the accumulation of LPG and natural gasoline at the gas front sets up miscible displacement.

First, high pressure gas is injected at pressures in excess of 3000 psi. The exact pressure depends upon the temperature of the reservoir and composition of the reservoir oil. Secondly, as the natural gas flows through the reservoir and contacts oil, LPG and natural gasoline, which we shall call intermediates, (and some other components in lesser amounts) are evaporated into the injected gas. At these high pressures the injected gas is undersaturated with respect to LPG and natural gasoline so that it extracts some of these components out of the oil, becoming much like a rich condensate reservoir gas.

Next, the injected gas, enriched with the intermediates, flows ahead to contact fresh reservoir oil. The enriched injected gas is miscible with the reservoir oil contacted downstream because of the intermediate components present; and, therefore, miscible displacement washes out the oil.

Fig. 2 is a schematic cross section of this type of flow displacement. The dark fluid is reservoir fluid. Just behind that is gas that has been substantially enriched with LPG and natural gasoline. This material washes out the oil. Back of this is additional enriched gas; however, this zone is probably not suitable to miscibly displace oil, whereas it will miscibly displace the enriched gas ahead of it. And then following this is the gas which miscibly displaces the slightly enriched gas ahead of it. The little islands of bypassed oil are included as a gesture of practicality since probably some zones are not immediately cleaned out of oil. But it is believed that gradually the oil bypassed in this fashion is washed out as indicated by the shrinking islands of residual oil.

The susceptibility of a reservoir fluid to this type of displacement at practical pressures depends on the existence of an adequate concentration of intermediates in the reservoir oil; and the greater the concentration, the lower the pressure at which we can successfully miscibly displace the oil. Fig. 3 is a graph which shows the effect of intermediate concentration in the oil upon the miscibility pressure. On the horizontal axis is plotted a measure of the intermediate concentration in the crude. What is actually plotted is the mol percent ethane through hexane divided by the molecular weight of the C_7+ fraction. This is merely a convenient grouping of commonly available analytical data to express in an approximate fashion the concentration of intermediates in the oil. On the vertical axis is plotted the pressure required at the front to obtain miscibility. Note how the pressure is sharply low-

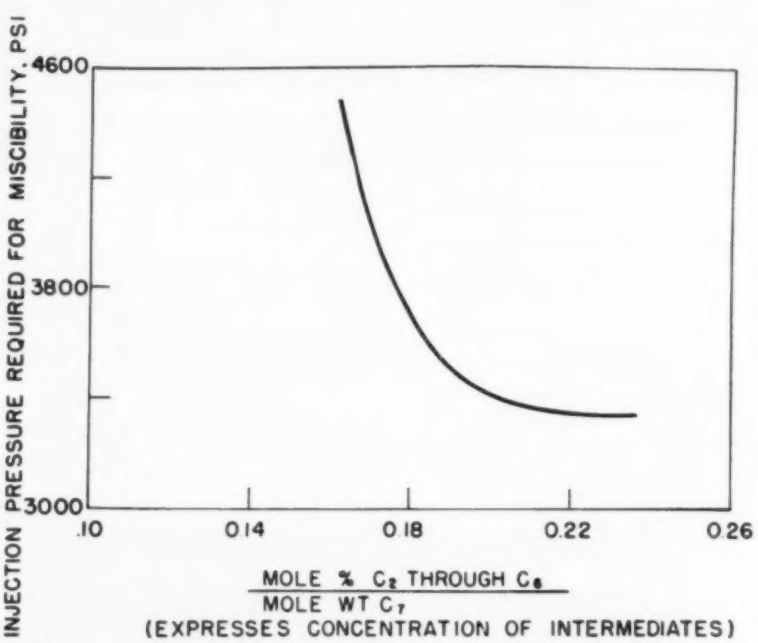

FIG. 3. Effect of concentration of intermediates in the oil upon the miscibility pressure. With an increasing portion of intermediates in the oil, the pressure required to miscibly displace the oil is decreased.

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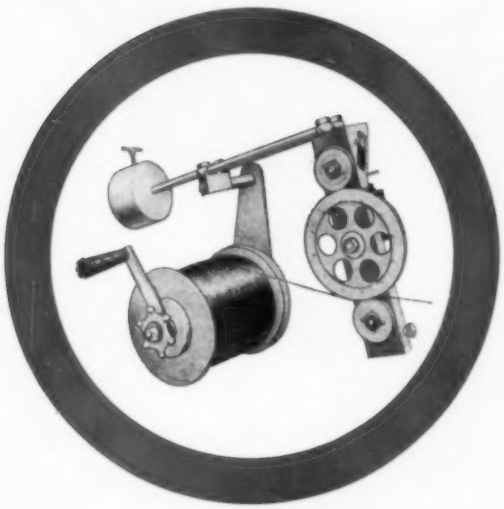

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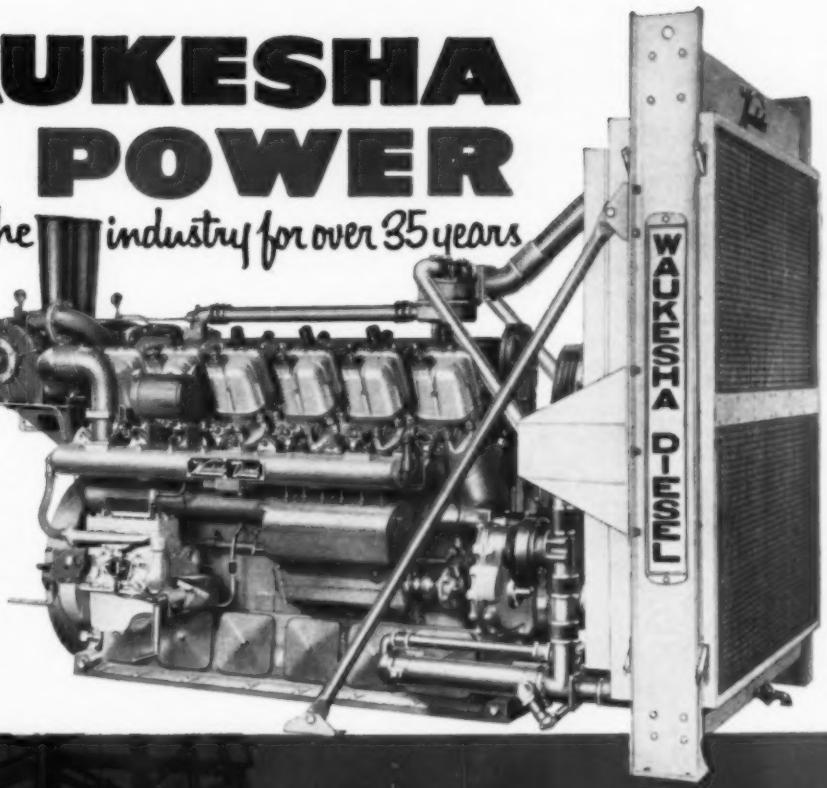

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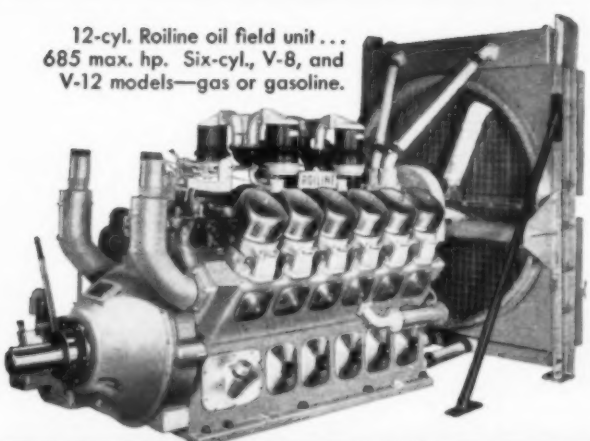

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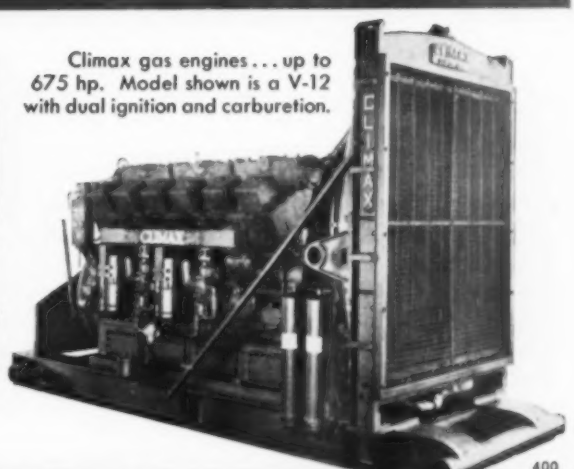

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ered by increasing amounts of intermediates. A high concentration of intermediates in a reservoir fluid is usually indicated by the API gravity. Oils with API gravities of over 35 deg are likely candidates for this type of process.

The main requirements, then, for carrying out a high pressure gas injection process are (1) a suitable reservoir oil, that is, one with a high concentration of intermediates, and (2) a reservoir depth that will permit the use of reservoir pressures in excess of 3000 psi. There are a number of reservoirs which meet these criteria, and this process has a reasonably wide application. However, only a small fraction of all reservoirs will meet these conditions, so we need other processes. This is basically why in some of the other miscible displacement processes, propane or LPG must be *injected* along with or ahead of the natural gas. If we can't operate a reservoir at a high enough pressure to evaporate the required intermediates from the oil, then we will operate at a lower pressure and inject the intermediates.

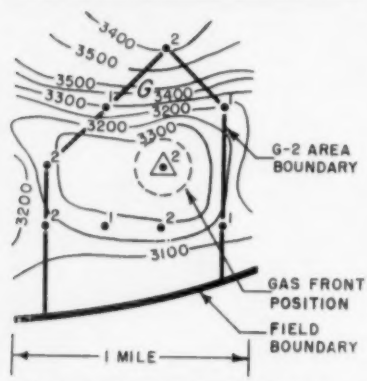

FIG. 4. Typical injection block shows high pressure gas injection well (triangle) surrounded by producing wells (black dots). The dashed circle around the injection well represents the approximate position of the gas front in an early stage of the injection.

High pressure gas injection has been in operation for the past nine years in the Devonian formation of the University Block 31 field. The field is located in Crane County in West Texas. We estimate that this operation will yield about three times as much recovery as by natural depletion solution gas drive mechanism. We are injecting about 40 million std cu ft of high pressure natural gas daily and are trying to maintain a pressure of about 3500 psi at the front to insure miscible sweep.

The field covers about 7000 acres. The Devonian formation is on an anticline structure at a depth of about 8000 ft. It has a gross thickness of approximately 1000 ft. Seventy-three wells are presently completed in the Devonian on an 80 acre spacing. Fifteen of these wells are currently being used for gas injection, basically in a nine-spot injection pattern. We have much evidence that the miscible displacement is proceeding as expected.

Fig. 4 represents one of the injection blocks at the southern end of the field. The triangular well in the center is the injection well, and the black dots surrounding it are the producing wells. The dashed circle around the injection represents the approximate position of the gas front, indicating that a substantial portion of the reservoir remains to be swept. This is a typical injection block in the field. Evidence that the drive is proceeding efficiently comes from some closer spaced injection-production wells in the field where gas breakthrough time has been about as predicted for miscible drive.

The physical equipment at the surface for this installation is a complex and costly array. The design and operation of the 10,000-hp compression plant, the associated gasoline plant, and the field separation, gathering, and injection systems are fit subjects for entire discussions themselves. Entirely beyond the reservoir considerations, there is a vast coordinated effort of process engineers, production engineers, mechanical design engineers, and operations staff involved in making this project operate.

W. F. Kieschnick, Jr. *received a BS degree in chemical engineering from the Rice Institute in 1947. He had a year of study in Physics-Meteorology at UCLA in 1943.*

Since graduation, he has worked for The Atlantic Refining Company in the Crude Oil Production Division of the Research and Development Department in Dallas. His assignments have included work in the areas of reservoir engineering, phase relations, miscible displacement of crude oil, drilling and well completion studies, and administrative work. At the present, he is Assistant to the General Manager of Exploration.

Condensing Gas Drive Process

If we do not have a reservoir fluid which can furnish an adequate amount of LPG or natural gasoline to the injected gas at reasonable pressures to form our intermediate zone, then we must inject this material. If we inject propane or some other LPG product ahead of natural gas or mixed with natural gas, we can carry out the miscible displacement operation at a much lower pressure. Of course, the cost of the LPG is no small factor to reckon with, but many times it is justified by permitting miscible displacement to occur at a reasonable pressure.

One particular process that has been proposed in this connection is the condensing gas drive process or enriched gas drive.[4] In this process LPG is added in large amounts to natural gas so that an enriched gas is injected from the surface. The composition might be 50 percent natural gas and 50 percent propane. As the injected gas flows into the reservoir, some of the intermediates from it are dissolved or condensed into the oil, yielding some intermediate enriched oil. Fresh, rich gas flowing up to the front contacts the enriched oil and is miscible with it because of the high intermediate composition, and in this fashion miscible displacement is set up. For economic reasons a slug of enriched gas would probably be injected, followed by cheaper natural gas.

Propane Slug Process

Still another way to inject LPG into a reservoir for miscible displacement is to inject it in a relatively pure form ahead of natural gas.[5,6,7] Here the idea is once again to set up a zone of intermediate compounds, propane and butane usually, between the gas and the oil, as illustrated in Fig. 5. At the front side the LPG miscibly displaces oil and thereby pushes all of the oil ahead; and on the back side the gas, generally at a pressure above 1000 psi, miscibly displaces the slug of LPG. The controlling pressure in this operation is at the back side of the slug. Reservoir oil and propane are usually miscible over a wide range of reservoir conditions and at fairly low pressures. On the other hand, something usually in excess of 1000 psi is the pressure required for natural gas to miscibly displace propane.

The main problem with the propane slug process is determining the appropriate slug size. There will be mixing at the front between the oil and the propane, and there will be mixing at the rear of the slug between the gas and the propane. Ultimately, if the slug is small enough, this mixing will proceed from front and rear and meet, and the slug will finally be broken down and spread out. We could put

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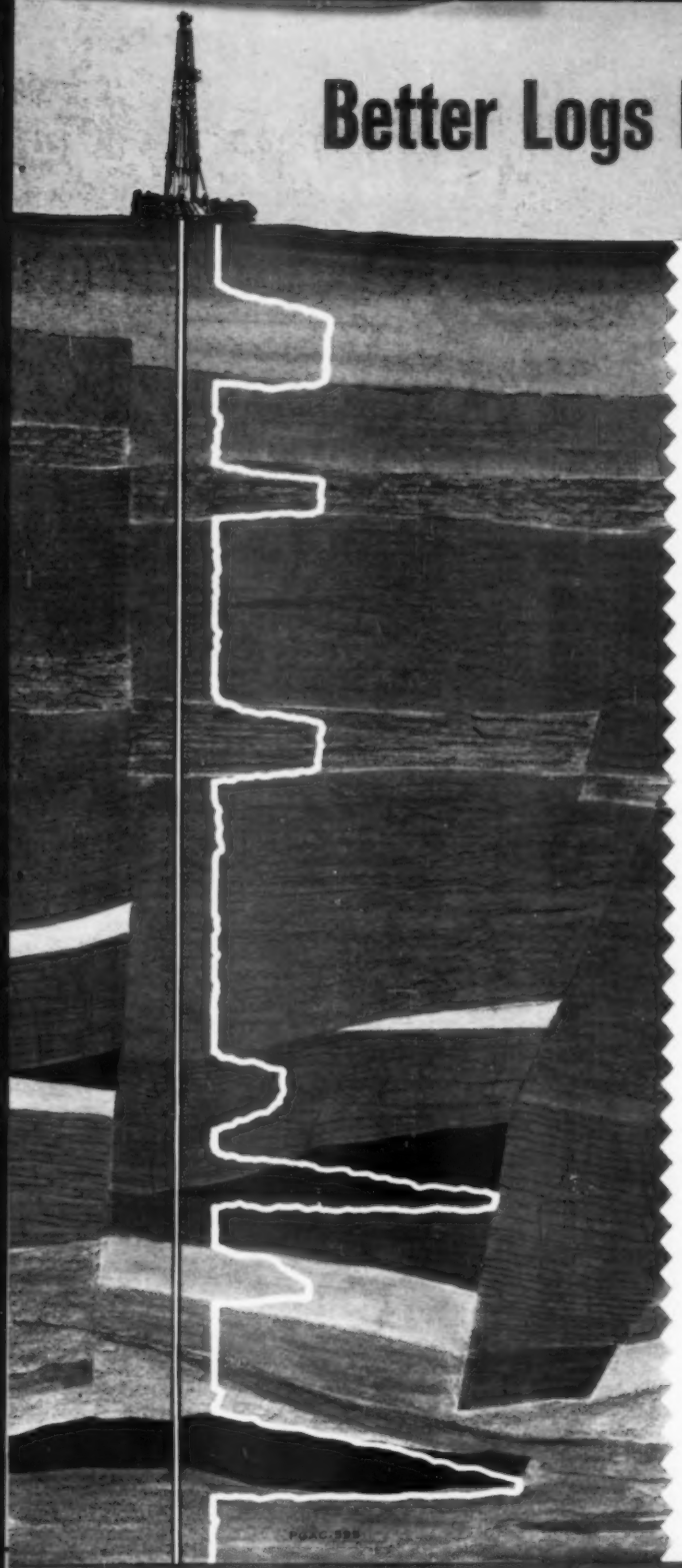

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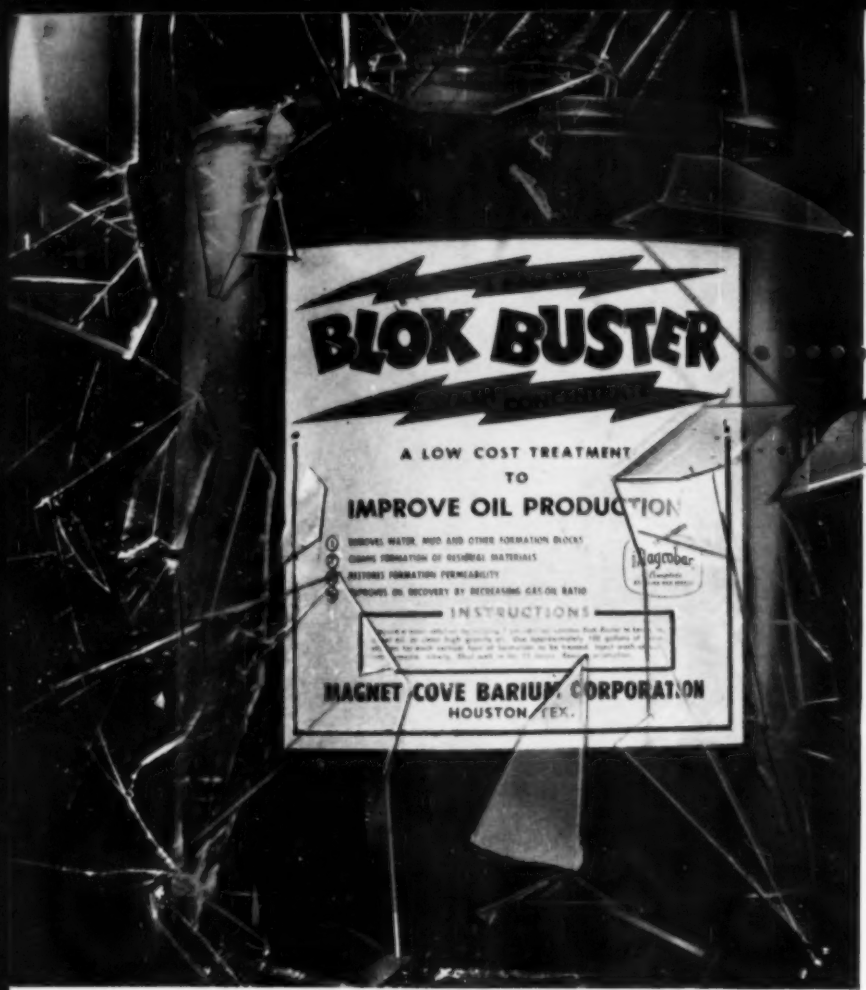

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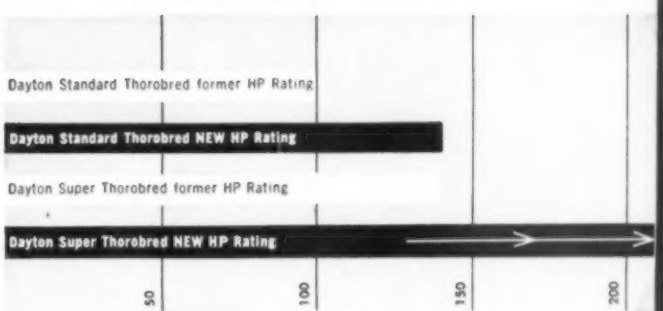

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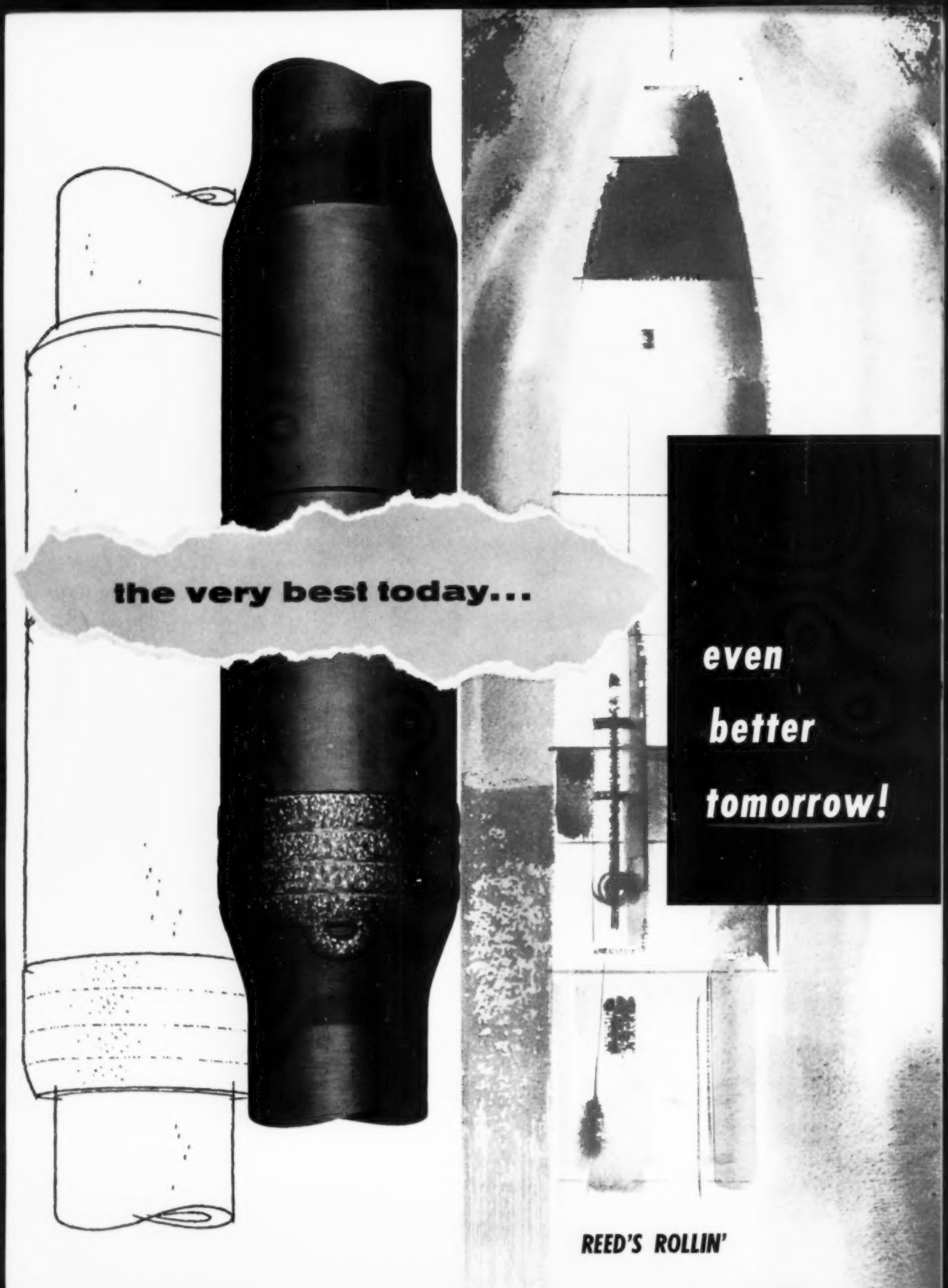
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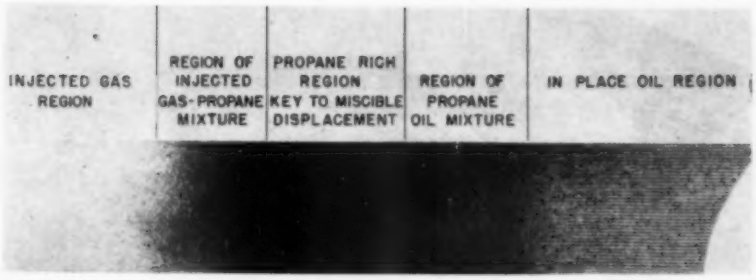
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FIG. 5. Schematic representation of propane slug process illustrates the injection of a slug of propane which is followed by the injection of gas. This process does not depend upon the extraction of intermediates from the reservoir oil to achieve miscible displacement of the oil.

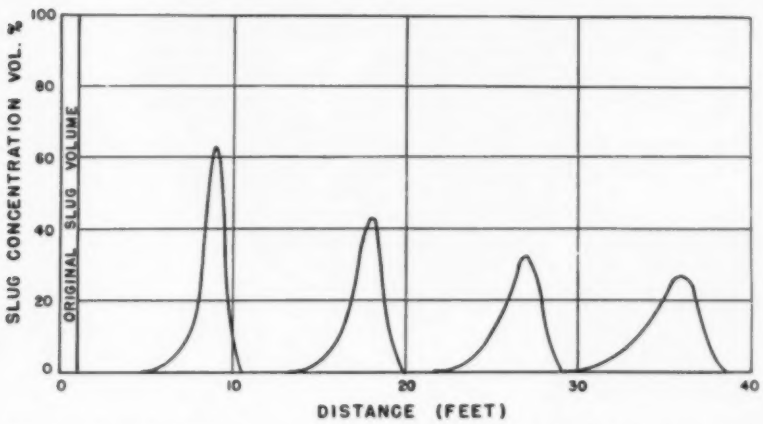


FIG. 6. Effect of path length upon the injected propane slug shows that the band of propane tends to become wider with a corresponding decrease in propane concentration as the front moves away from the injection point.

in a very large slug and be technically sure that it would proceed throughout the reservoir and guarantee miscible displacement. This would be costly. As a first approximation propane costs as much as oil, and we cannot afford to inject excessive amounts of a product which is no less costly than the product that it pushes out.

Fortunately, slug dissipation seems to occur in a fashion that works in the direction of minimizing volume requirements. Fig. 6 shows the progress of a propane slug through an experimental reservoir in the laboratory. On the horizontal axis is plotted the distance from injection point, and on the vertical axis is plotted the concentration of propane in the slug. The initial band of propane injected is about a foot wide, and it consists of 100 percent propane. By the time the slug has advanced about 10 ft through the experimental system, it has been spread out some at the front and back, and the peak propane concentration is now a little over 60 percent. In the next 10 ft it is spread out more, but the dilution is proceeding in a fashion that is less than proportional to the distance traveled. We can tolerate propane concentrations down to 30 or 40 percent in these slugs and still achieve miscible displacement at the front and rear boundaries.

There is another way to express these results. In a 20-ft length reservoir the slug size required for miscible displacement in this system is about 4 percent of the pore volume. In a 123-ft reservoir we were able to miscibly sweep the whole reservoir with a slug that started out as 1½ percent of the reservoir. We have calculated that in a 1000-ft reservoir length these results would be extrapolated to indicate the need for 0.6 of the pore volume. All of these results are for specialized conditions and are not directly applicable to an actual field case — however, the concept developed seems valid. We were finding here that the requirements for additional slug materials increased only as a square root of distance rather than as a direct function of distance.

With all of these types of studies we were led to the conclusion that propane slug sizes of the order of 2 to 5 percent of the swept reservoir pore volume would be adequate to miscibly displace through reservoir distances in realistic reservoir situations. A propane slug this small is in the realm of economic feasibility.

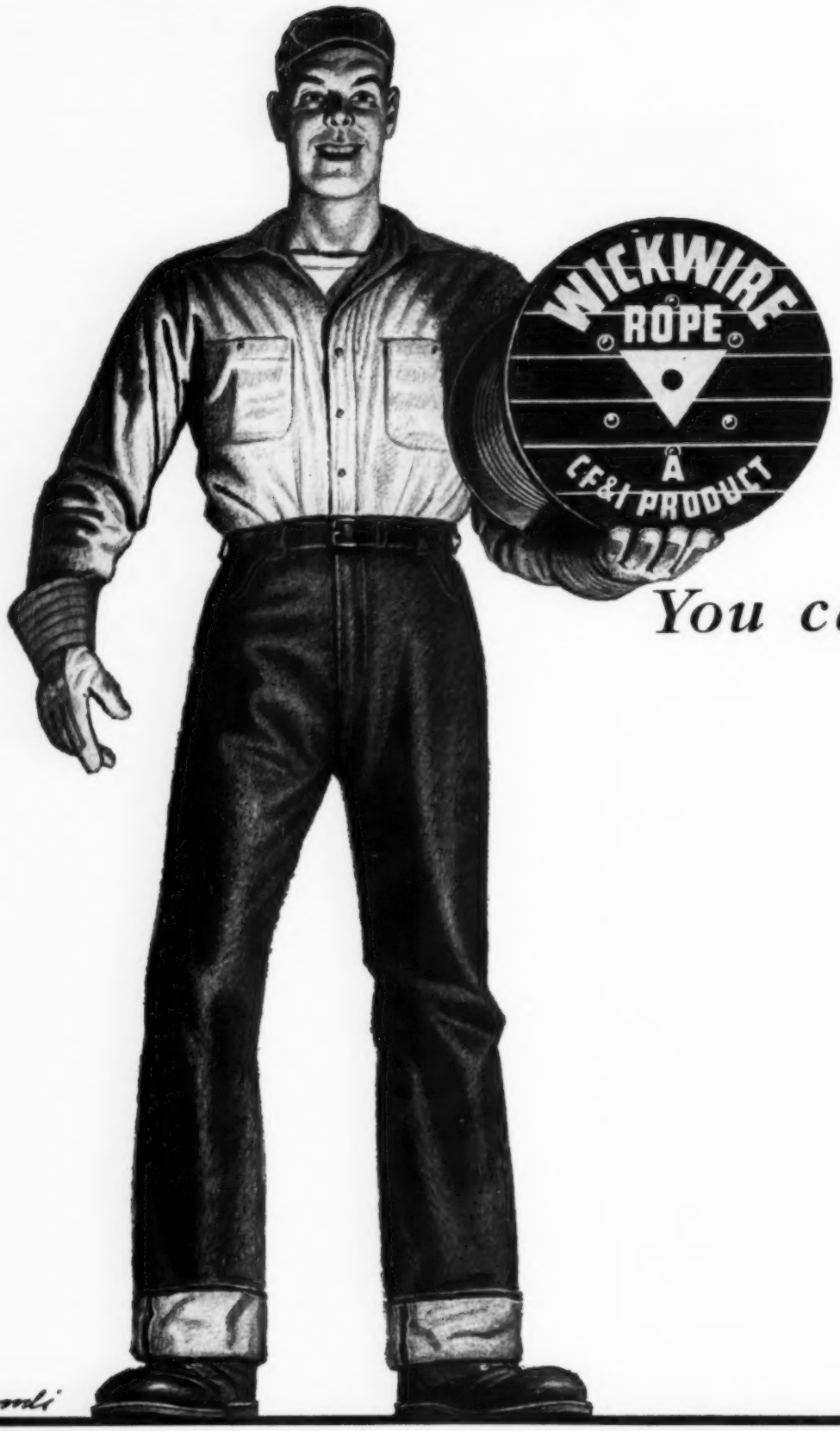
Phase Relations of Miscible Displacement Processes

Mixtures of natural gas, LPG, and crude oil are complicated multi-component systems. It is difficult to predict the amount and composition of phases that mixtures of these materials will exist in at elevated pressures. However, if we make certain simplifying assumptions, we can represent and predict the phase relations of these systems well enough to understand the mechanism and interrelationship of the processes we have been discussing.

The phase relations of a three-component system for a given pressure and temperature can be represented on a triangular diagram, as in Fig. 7. The area in the triangle represents all of the combinations that could exist of these three components. For this diagram, the pressure is constant at 3000 psig and the temperature constant at 160 F. The upper apex of the triangle represents 100 percent methane, and the horizontal base line, zero percent methane. Points in between represent in a linear fashion different concentrations of methane. In like fashion the decane composition scale begins at zero at the right hand side of the triangle and increases to 100 percent at the lower left apex. The butane scale begins at zero percent at the upper left hand side of the triangle and increases to 100 percent at the lower right hand apex.

All combinations of these three components which give a two-phase system, gas and liquid in equilibrium, are denoted by the area at the upper left hand side of the triangle enclosed by the phase boundary curve. All other combinations represented in the triangle exist in a single phase, and there will be no interfaces. The line marked by series of G's is called the *dew point curve*. The line marked by a series of L's is the *bubble point curve*, and the point C is the *critical point*. The lines within the two-phase area connect compositions of gas and liquid which exist in equilibrium, and they are called *tie lines*. For example, the point S_2 represents a combination (85 percent methane, 8 percent butane, and 7 percent decane) which exists in two phases and has a gas of composition G_2 and a liquid of composition L_2. Gas just above the critical point on the boundary curve is almost the same composition as liquid just below the critical point on the boundary point curve. A line drawn between two points represents all the combinations of fluids whose compositions are represented by the end points.

We can use a three-component system as a simplified model for the multi-component systems. For example, we



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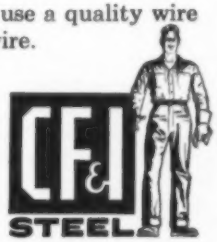

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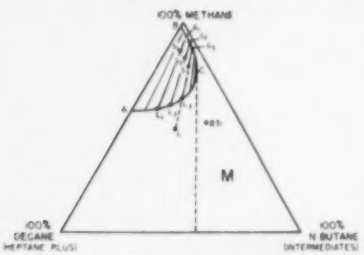


FIG. 7. Composition of the phases in a methane, n-butane, decane system at 3000 psig and 160 F. Area within the curved boundary represents all combinations of the three components which give a two-phase system, gas and liquid in equilibrium.

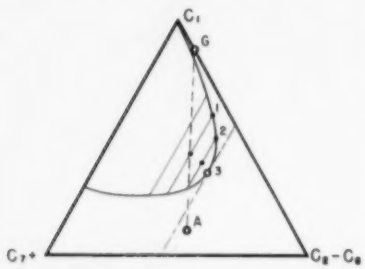


FIG. 8. Phase relations of an example reservoir oil are used to determine the response of this oil to high pressure gas injection.

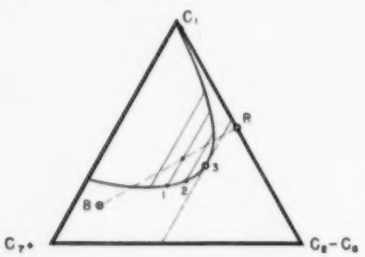


FIG. 9. Phase relations of an example reservoir oil illustrates the process of the condensing gas drive.

can let methane be one component in a multi-component system. We can let the intermediates, ethane through hexane, be one component; and we could let the heptane-and-heavier components be a third component. In this fashion, we can use the well established concepts for three-component systems to develop concepts for the complicated multi-component systems. This is taking liberties, and it is only an approximate representation; but it will suit our purpose.

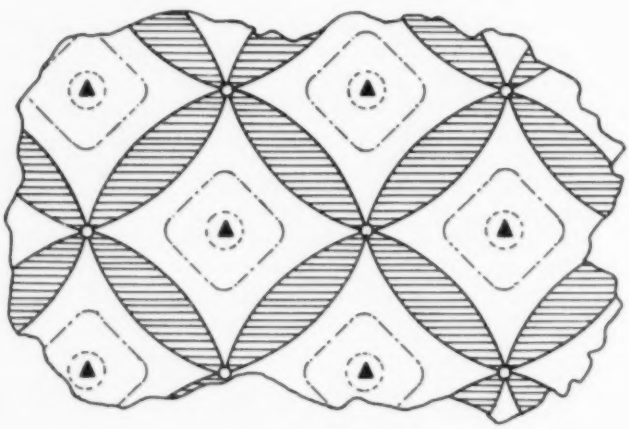
High pressure gas injection. With this in mind, let us examine the phase relations of the high pressure gas injection process, the process in which the bank of intermediates is furnished from the reservoir fluid itself. Fig. 8 represents the analysis of an example reservoir oil of the composition represented by the point A. If we inject a gas of composition G at the high pressure represented by this diagram (e.g., 3500 psi), some gas G will mix with reservoir oil A; for example, in the combination represented by the dot on the dashed line connecting G and A. This combination will split into a gas of composition marked 1 on the dew point curve, and an oil of composition where the tie line intersects the boundary curve below. Note that the gas at 1 is richer in intermediates, $C_2 - C_6$, than the injected gas G. If this enriched gas 1 flows ahead and mixes with more reservoir oil A, another combination of the two will be at the other interior dot within the phase boundary. This new mixture would split into gas 2 and some other liquid indicated below.

The injection gas would be progressively enriched in successive contacts with oil by the evaporation of intermediates (and some C_{7+}) until the gas reaches the critical composition at point 3. Now any mixture of the critical composition gas and oil A will lie in the one-phase region so there will be a miscible displacement. The main point here is that the oil A had a composition below the bubble point curve and to the right of the line tangent to the critical and parallel to the tie lines. This merely indicates that the oil is undersaturated with respect to the gas and that it has a plentiful supply of intermediates.

Condensing gas drive. Let's examine the condensing gas drive process in this fashion. (Fig. 9). Assumed reservoir oil B does not have enough intermediates in it to yield its own bank of intermediates like oil A did. However, if we inject a gas R already enriched with intermediates (in this example 50 percent methane and 50 percent propane), miscible displacement will ultimately occur.

If we inject gas R to mix with reservoir oil B, one mixture would be that represented by the dot within the border curve. This mixture would split into a gas and oil, with the oil having composition marked 1. Fresh injected gas R flowing up to contact the oil 1 would split into gas and liquid, with the liquid for example, being represented by the composition 2. The injected gas R is being stripped of its LPG which is accumulating in the oil. Note that this is a reverse of the high pressure gas mechanism just described. Ultimately, the reservoir oil near the front will be enriched by propane taken from the injected gas until the composition is at the critical, at point 3. Thereafter gas R will miscibly displace fluid 3 because any combination of these two fluids lies in the one-phase region.

Propane slug process. Now let's look at the propane slug process on this di-



▲ — INJECTION WELLS

○ — PRODUCTION WELLS

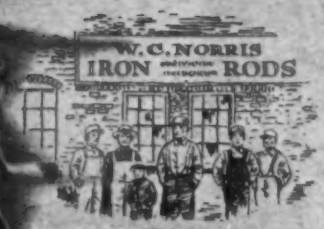
FIG. 10. Advance of injected front in a five-spot pattern is illustrated at three stages during the progress through the reservoir. Light areas have been swept by the injected fluid.

The W.C.NORRIS NAME IS AS OLD AS OIL IN U.S. INDUSTRY-1858--1959

The founder of W. C. Norris, Manufacturer was born shortly after the completion of the Drake Well, which initiated oil, and its products, as a part of the American industrial scene.

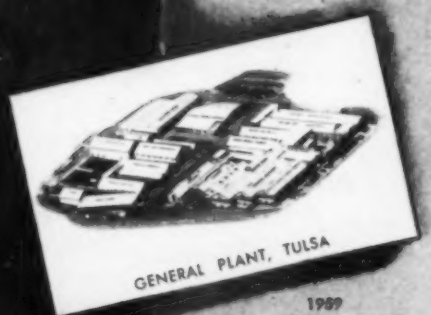
1882
TIONA, PA.

The father of W. C. Norris, was engaged in the business of industrial handicraft, when his son was born. W. C. Norris opened his own shop at Tiona, Pennsylvania in 1882. He was among the first to make and market 'iron rods' on special order for the infant oil production business.



1910
TULSA, OKLA.

W. C. Norris, Manufacturer, and its aims and efforts, has been companion to the growth of the petroleum business as a major industry ever since those modest beginnings. Often in these years the role of pace-setter in it has been taken by W. C. Norris in design, development and marketing of specialized oil field products, which were themselves solutions to problems, not expedients therefor.



GENERAL PLANT, TULSA
1959

Sucker rods—bull plugs and swages—refinery fittings—O-Ring seal valves—wellheads, all field tested and proven, each a representation of inherent quality, devotion to design and purpose, unremitting care in specification and inspection, make the lines upon which we are proud to say our reputation rests. We appreciate our customers, both distributor and user, for their loyalty and confidence, THROUGH all these years . . . and we're looking forward to the next hundred.

SUCKER ROD PLANT, TULSA
1959

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DIVISION OF DOVER CORPORATION
TULSA, OKLAHOMA, U. S. A.

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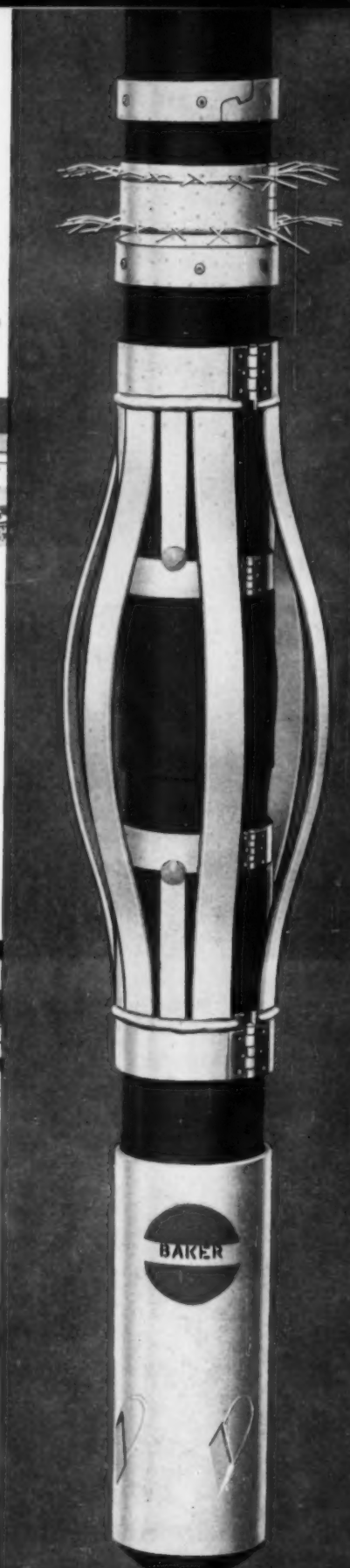
* *Casing on Bottom Safer and Faster*

* *Protection of Productivity*

...Specify BAKER PRIMARY CEMENTING EQUIPMENT



Baker Wall Scratchers

HINGE-LOK or SOLID-RING Models for all popular casing sizes.

Baker Casing Centralizers

HINGE-LOK or SOLID-RING Models with Multiple Ranges for all popular casing sizes.

Baker Fill-Up Equipment

DIFFERENTIAL Shoes and Collars for *any* well, and economical FLEXIFLOW Shoes and Collars for wells of *moderate* depth.

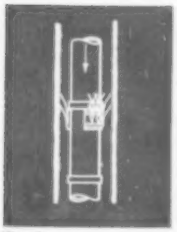


Fig. A

Fig. B

Fig. C

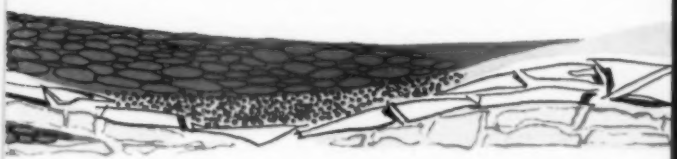
Fig. A Scratcher wires, retained by integral hinged mounting, swing freely upward and do not remove mud cake while running in.

Fig. B Even when casing is lifted out of the slips, the entire Scratcher remains stationary. Only when reciprocated, and

Fig. C ...only at the cementing area does the "scissors" action of the crossed wires remove mud cake.

Baker Scratchers remove mud cake only from the cementing area; this "controlled scratching" protects productivity.

While running in, the scratcher wires automatically swing upward along the casing, where they are safe from damage; permit free, unrestricted lowering of the casing; and do not disturb or remove mud cake. There is no danger of "balled-up" mud collecting on the scratcher wires to plug the annulus and contribute to pressure surges with possible "mudding-off" of the producing zone. Only when the cementing area is reached and the casing is reciprocated do the double rows of strong "crossed" spring wires automatically reach out, dig in, and remove the mud cake with efficient "scissors" action.



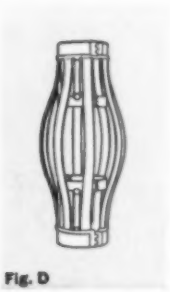


Fig. D

Fig. E

Fig. F

Fig. D "Extended" Range HINGE-LOK Baker H-25 Casing Centralizer. Product No. 9113.

Fig. E "Normal" Range HINGE-LOK Baker H-20 Casing Centralizer, Product No. 9112.

Fig. F "Slim Hole" SOLID-RING Baker G-15 Casing Centralizer, Product No. 910-G.

Baker Centralizers assure cementing clearance. "No-scrape" design prevents "balling", plugged annulus and stuck casing.

The QUALITY of Baker Casing Centralizers starts with "sled-runner" springs made of high quality spring steel—tested and pre-set by flattening in hydraulic presses—then butt-welded to collars to form a unit of great strength. Pre-setting of the springs to the pre-calculated optimum bowed height enables each centralizer to pass tight spots or dog legs without damage to the assembly, and ensures GREATER CENTERING FORCE for maintaining annular clearance for cementing.

Baker Centralizers do not remove mud cake which could plug the annulus, contribute to pressure surges and restrict productivity.

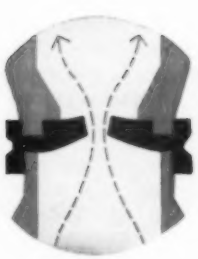


Fig. G

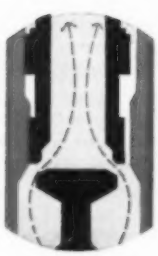


Fig. H

Fig. G Variable FILL-UP Valve as used in FLEXIFLOW Equipment.

Fig. H Variable FILL-UP Valve as used in DIFFERENTIAL Equipment.

Baker Fill-Up Equipment saves time in running casing, but does not create pressure surges that reduce productivity.

Destructive pressure surges—often created when casing equipped with conventional floating equipment is lowered into the well—can now be avoided. The Variable Valve in either Baker DIFFERENTIAL or Baker FLEXI-FLOW "Fill-up" Shoes and Collars, permits casing to fill from the bottom up; eliminates expensive, time-consuming surface filling; and automatically coordinates the *rate of fill* with the *rate of lowering* to AVOID high pressure surges. Baker FILL-UP Equipment permits the casing to be lowered at normal rates, saving rig time and reducing danger of sticking the pipe; chances for successful primary cementing are increased; formations are protected from high pressure surges which can impair their productivity.

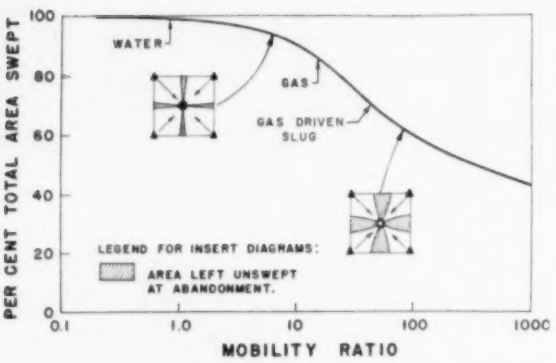


FIG. 11. Effect of mobility ratio of injected and reservoir fluids upon the total reservoir area swept. Because of the high mobility of gas, all gas driven miscible displacement processes have a poorer sweepout efficiency than waterflooding.

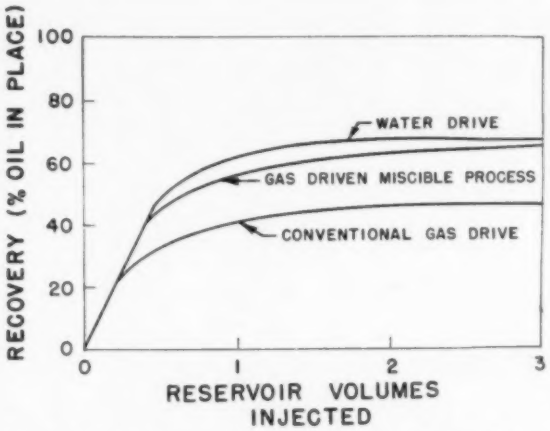


FIG. 12. Total recovery for different drives as a function of reservoir volumes injected. Varying recovery percentages are due to the different fluid mobility ratios involved in the three processes.

agram. The reservoir oil B would be miscibly displaced by propane represented at the lower right hand apex of the triangle. This propane would be miscibly displaced by methane, represented at the upper apex. The path of compositions through the cross section of flow does not enter the two-phase region. It is evident that as long as the slug is maintained there will be miscible displacement.

Sweepout Limitations of Gas Driven Miscible Processes

The miscible processes have one particular shortcoming: The gas driven miscible processes have a relatively poor sweepout pattern efficiency.

It would be useful to discuss the several factors to consider in estimating the actual recovery from an injection operation. The first, called unit displacement efficiency, refers to the fraction of oil recovered in the swept volume. In a small unit of the reservoir volume which is completely invaded by injected fluid, the recovery from this unit volume would be this factor. In the miscible displacement processes this efficiency is essentially 100 percent. We recover all of the oil in the pores invaded by the miscible sweeping phase.

A second factor, channeling, is a measure of the gross departures from homogeneity: Stratification, variations in permeability, porous and tight streaks in the reservoir. These large inhomogeneities will prevent injected fluids from contacting some of the reservoir.

Another factor which must be considered is the sweepout pattern efficiency. This is strictly a geometric consideration of the fraction of reservoir contacted by the invading phase, considering only the well pattern. The fluid flow streamlines in a reservoir, even if the reservoir were perfectly homogeneous, are such that we do not usually sweep out the total reservoir.

In a reservoir with a five-spot injection pattern, the sweepout pattern somewhere near abandonment would look like Fig. 10. The light areas have been invaded by injected fluid. The dark areas have not been invaded. It has been found that the efficiency of sweepout in this pattern is primarily controlled by the fluid mobility ratio; that is, the mobility behind the front divided by the mobility ahead of the front. The mobility expresses the ease with which a fluid flows and is defined as the permeability divided by the viscosity. If the most mobile fluid is flowing behind it will tend to cusp in to the producing well sooner and have a relatively inefficient sweep by the time a certain abandonment producing cut or producing fluid ratio is reached. On the other hand, if the displacing fluid is less mobile than the fluid being pushed, it will tend to be restrained from breaking through early and from arriving at the production well in high fluid ratios.

These effects are illustrated in Fig. 11. When the displacing fluid is 0 to 1 times the mobility of the displaced fluid, the sweepout is high — approaching 100 percent. At the other extreme, when the displacing fluid is 100 times or more as mobile as the displaced fluid, the sweepout is poor.

There is wide agreement in the industry about the relative effects of mobility ratio, but there is still some disagreement on the absolute magnitude of the sweepout efficiency to be associated with any given mobility ratio. The data cited here were developed at Atlantic.

It is useful to compare the sweepout efficiency of several types of drives. Water injection frequently has a mobility ratio of one and a sweepout approaching 100 percent by abandonment. Low pressure gas sweep has a mobility ratio of about 10 with a sweepout efficiency near 85 percent at abandonment. Poorest of all is a gas-driven miscible slug process with a mobility ratio of about 75 or greater and a sweepout efficiency at abandonment of approximately 70 percent or less. Because highly mobile gas is involved, all gas driven miscible displacement processes have a poorer sweepout efficiency than waterflooding. This is a relative weakness of the gas driven miscible process.

This is further illustrated by comparing total recovery from waterflooding with total recovery from a gas driven solvent slug process (Fig. 12). We believe that the advantage of high recovery from miscible sweep, where the front sweeps, is just about offset by the disadvantage in area swept because of poor mobility ratio. This means that on the average we would view a gas driven propane slug process as no better in recovery than waterflooding.

We would like to see an operation with the high sweepout efficiency of waterflooding and the high displacement efficiency of the miscible slug process. The idea that there might be some combination of the waterflooding process and miscible sweep process to

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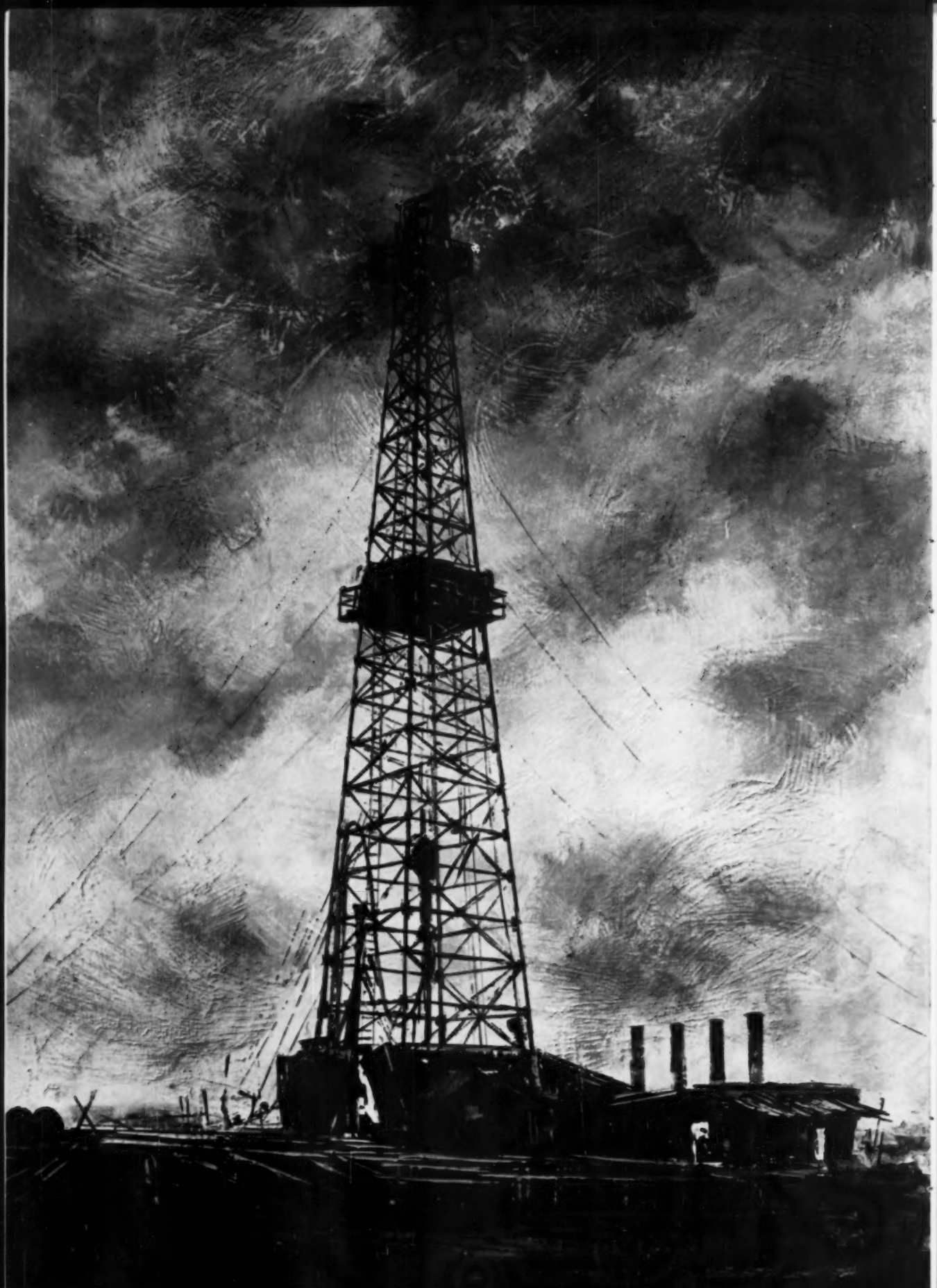

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BY HUGHES "TRI-CONE" BITS

THE DAWN of a new era in rock bit designing and the first long step toward the development of modern drilling techniques came, in 1933, with the introduction of the Hughes unit-type three-cone bits, equipped with self-cleaning cones. Self-cleaning cones were first proved on the Simplex bit in 1925.

The three points of rolling contact on bottom made the three-cone bit (later identified as "Tri-Cone") smoother running. The 50% more gage surface, fortified with tungsten carbide, made it possible for the three-cone bit to better hold the gage of the hole.

The unit-type "Tri-Cone" design triggered a rapid series of developments. It permitted Hughes engineers to concentrate on designing cutting structures to drill specific formations. And during the mid-30's, Hughes brought out its "tailor-made" bits — "a bit for every formation."

Instead of an all-purpose bit (which the first "Tri-Cone" bit had been), the "tailor-made" bits included the "S" bit for soft formations; the "OSQ" for formations on the softer side of medium hard; the "D" for medium hard formations; the "W" for hard formations, and the "HR" for extremely hard, abrasive formations. The unit two-cone bit was used primarily to dig soft, broken formations, and, today — greatly modified in design — is still used primarily for this purpose.

For their time, the "tailor-made" bits were a sensation. They tripled the rate of penetration and doubled the footage drilled per bit. Their success gave added emphasis to research and spurred the efforts of Hughes engineers. Each new advance opened the door to still further improvements, and step by step led to the present-day, high-performance, highly specialized Hughes bits.

West Texas, with its high percentage of hard and extremely hard abrasive formations, was a proving ground for the first "Tri-Cone" bits. As an example, take Gulf's J. T. McElroy 103—a record deep well for its time—12,786 feet. It took 26 months—March 21, 1933 to May 25, 1935—and 965 bits to drill this well. The lessons learned in those 26 months helped to speed the development of tailor-made "Tri-Cone" bits. In the illustration at the left, the artist has pictured the Gulf McElroy as it appeared while drilling in 1935. Large reproductions, suitable for framing, are available for the asking. Write: Adv. Dept., Hughes Tool Co., P. O. Box 2539, Houston, Texas.

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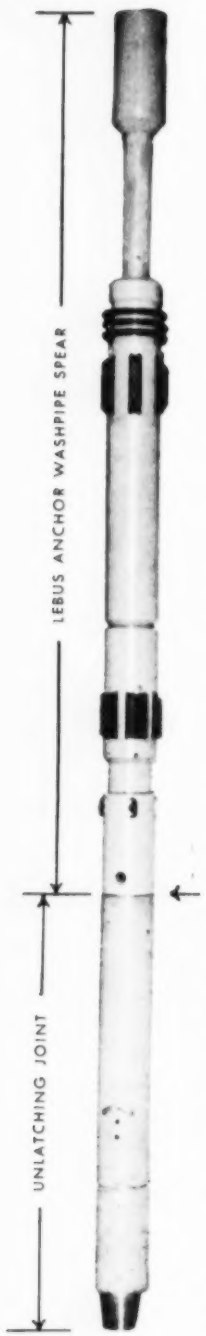
"TAILOR-MADE" BITS OF THE 30'S — "A BIT FOR EVERY FORMATION"

Type "S" Type "D" Type "OSQ" Type "W" Type "HR"

50TH ANNIVERSARY YEAR 1909 – 1959

LEBUS ANCHOR WASHPIPE SPEAR



POSITION A

Slips in a down and retracted position; friction block cage in downward position where it will rotate with the wash pipe during the wash-over operation. Also note, LeBus unlatching joint also in closed position.

Model JCF

FOR USE WITH WASHOVER PIPE

WASHOVER STUCK DRILL STEM TO WASH LOOSE AND CATCH OFF BOTTOM TO PREVENT DROPPING; TO WASHOVER AND PICK UP WHEN STUCK ON BOTTOM TO SAVE EXTRA TRIPS; USE AS BACKOFF TOOL TO WASHOVER SHORT SECTIONS OF LONG DRILL STRINGS AND MAKE STRING SHOT BACKOFFS.

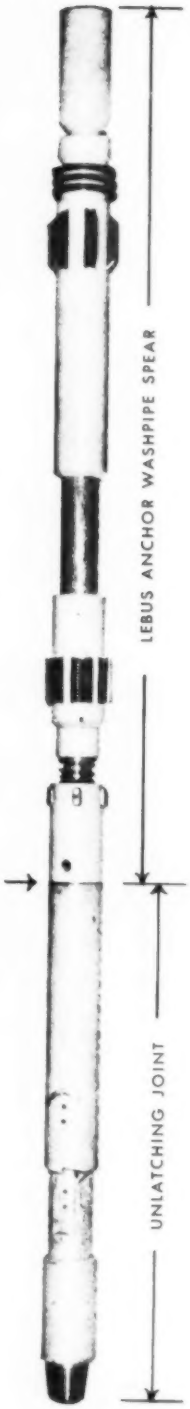
- This spear is anchored tong-tight inside the washpipe by the catching slips; this makes it easy to place spear in selected position.
- Can be located in any joint of washpipe without use of special landing collars or nipples.
- Can be used with knuckle joints, overshots, spears, short or long drill pipe stringers or other essential tools for connection to the fish.
- Washpipe is then lowered into well over top of stuck drill stem until spear makes contact. Then spear is connected tong-tight to the stuck fish. Anchor spear slips are released by the continued right hand rotation of the washpipe and a light pull torque.
- Stuck Fish can be recovered and brought out in ONE TRIP with LEBUS WASHPIPE SPEAR AND WASHOVER PIPE when bit and drill stem are stuck *off* or *on bottom*.
- Spear is always operative to automatically catch fish off bottom when Washpipe is being rotated; at a stand still; being raised or lowered (to make Kelly connection or for freeing the Washpipe and reaming shoe).
- When fish is stuck off bottom this spear prevents it from dropping after being washed or reamed loose.
- Spear operates by both hydraulic and mechanical action when fish starts to fall — either operating within 12 inches.
- To back off sections of stuck drill stem take a light pull torque with the washpipe and rotate to the left. This causes the slips to anchor and set up a rotation torque for making string shot back offs (of the washed over section) with the spear and washpipe.
- Slips in this Model JCF cannot be fouled by junk and set accidentally while making drill pipe connections.
- Drill Pipe Jars should be run above the Washpipe.
- The make-up and break-out principle of this spear allows the operator to run an unlatching joint between the spear and the stuck drill steam.

FOOTNOTE

The unlatching joint illustrated above should always be run between the spear and stuck fish. This joint is not a part of the tool for lease, but is a straight sale to anyone in the world by LeBus International Engineers, Inc., Longview, Texas.

Operating license and spears furnished outside the U. S. A. under lease agreemnt to all fishing tool companies, oil companies, or drilling contractors, but to Fishing Tool Companies only in the Continental United States. Write for operating manual, or at your request a WOSECO engineer will call and give you all operating facts and licensing details.

PATENT NOS. 2,804,151; 2,817,555; 2,879,849; 2,887,161 and 2,887,162 and other patents pending.



POSITION B

Catching and holding position; the spear is actuated into this position by raising the wash pipe or when the drill stem drops. Note: Control body up, slips expanded and unlatching joint in extended, catching position.

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To Open-Hole Straddle Test
Eliminate Tail Pipe
Insure a Good Packer Seat

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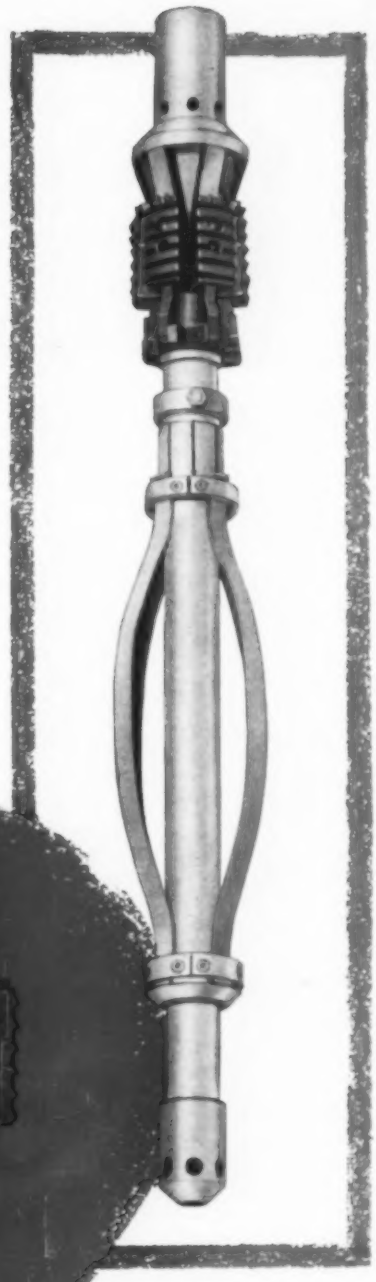


Many advantages are offered with this New Johnston Open-Hole Anchor. This is a slip-type device which has wide application because of its flexibility.

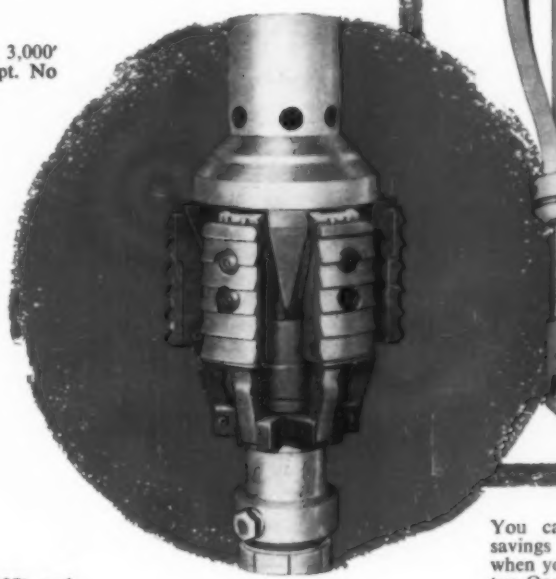
The slips are designed and built to give an extra large expansion diameter. This insures seating in wells where the hole may be slightly over drilled diameter.

The Open-Hole Anchor is easy to operate — has simple, positive-action "J" setting. A spring locking nut, incorporating buttress threads, allows easy re-setting of the anchor. When testing is completed, 6 turns to the right allows you to rotate out of the hole.

THE PROOF---

Hansford County, Texas
Conventional test at 8800' in 7⅞" hole. Used Anchor and single Bob Tail Packer only. No tail pipe. Mud weight 9.8 lbs., estimated 120,000 psi on packer and setting tool. No slipping of tool, no problems. Test successful.

Hansford County, Texas
Straddle test in 7⅞" hole between 3,000' and 4,000'. Anchor set on first attempt. No wash pipe used. Test successful.



Hansford County, Texas
Straddle test in 7⅞" hole between 6,000' and 7,000'. Tool set on first attempt. No wash pipe used. Test successful. Second test run between 5,000' and 6,000'. Packer failed to seat in washed out hole. Moved up hole, tool and packer set on first attempt.

Hansford County, Texas
Straddle test in 7⅞" hole between 5,000' and 6,000'. Tool set on first attempt. No wash pipe used. Test successful.

Liberal, Kansas
Straddle test between 5,006' and 5,016'. Tools worked well. No trouble. No wash pipe used. Test successful.

Liberal, Kansas
Selective zone tests between 3,907' and 3,915' and 4,672' and 4,680'. No problems encountered. Tools worked perfectly. No wash pipe. Test successful.

Liberal, Kansas
Two straddle tests run between 4,662' and 4,678' and 4,577' and 4,614'. Both tests O.K. No trouble whatsoever. Tools worked as expected. Test successful.

You can profit from the savings in dollars and time when you specify the Johnston Open-Hole Anchor. Ask your Johnston representative for full information. You'll be glad you did.

JOHNSTON DRILL STEM TESTING TESTERS

Eliminates the need for tail pipe on conventional tests and straddle tests.

Offers flexibility in finding packer seat. If seat is not obtained on initial attempt just pick up and re-set the tool.

P.O. Box 98, Houston 1, Texas

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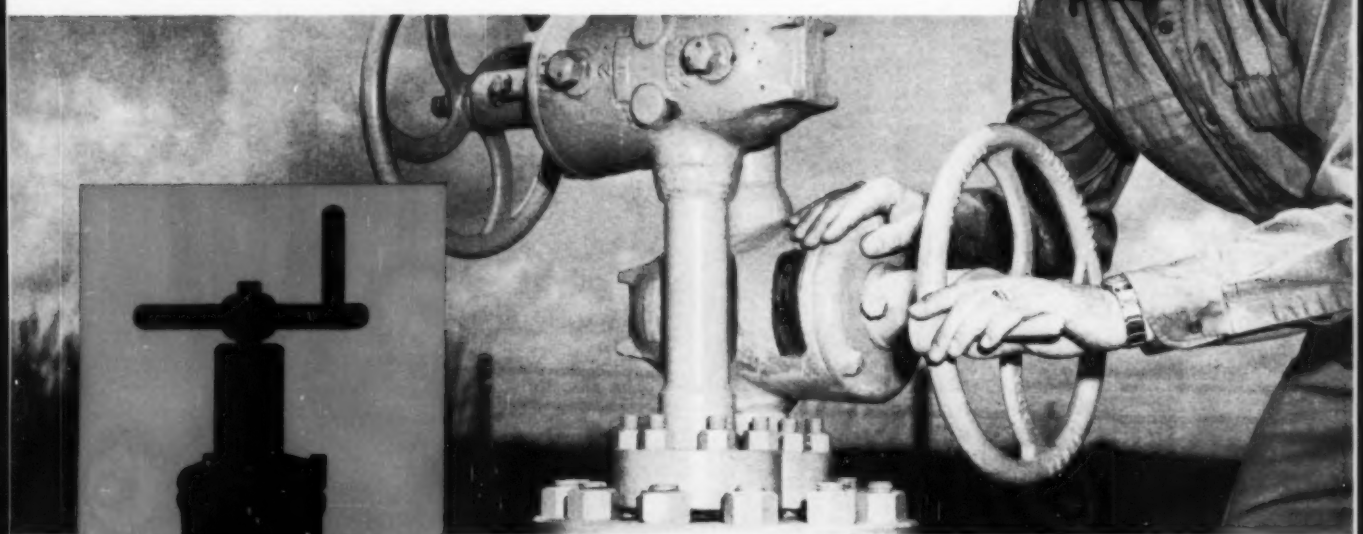

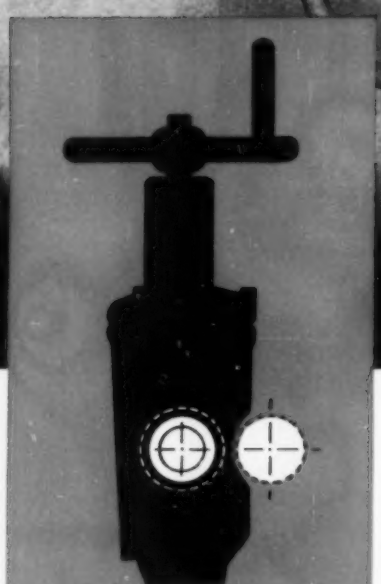

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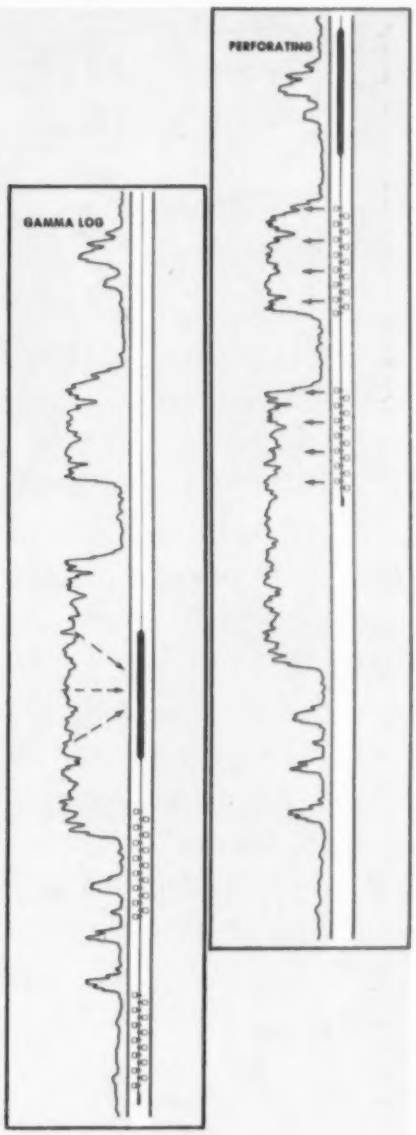

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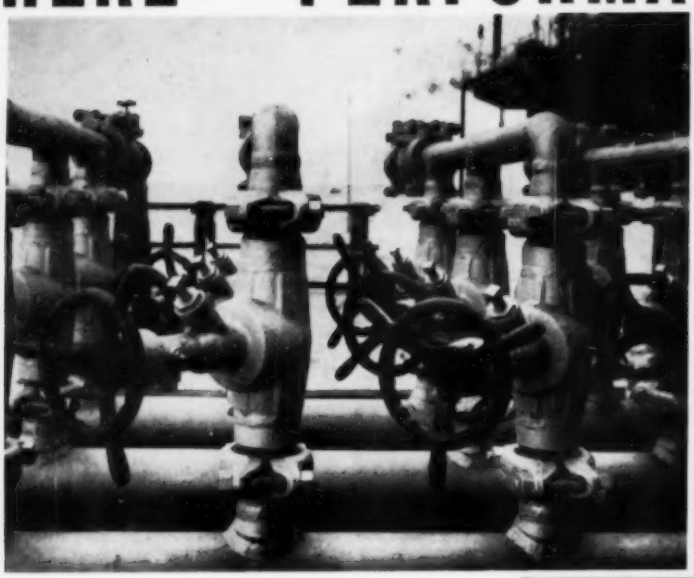

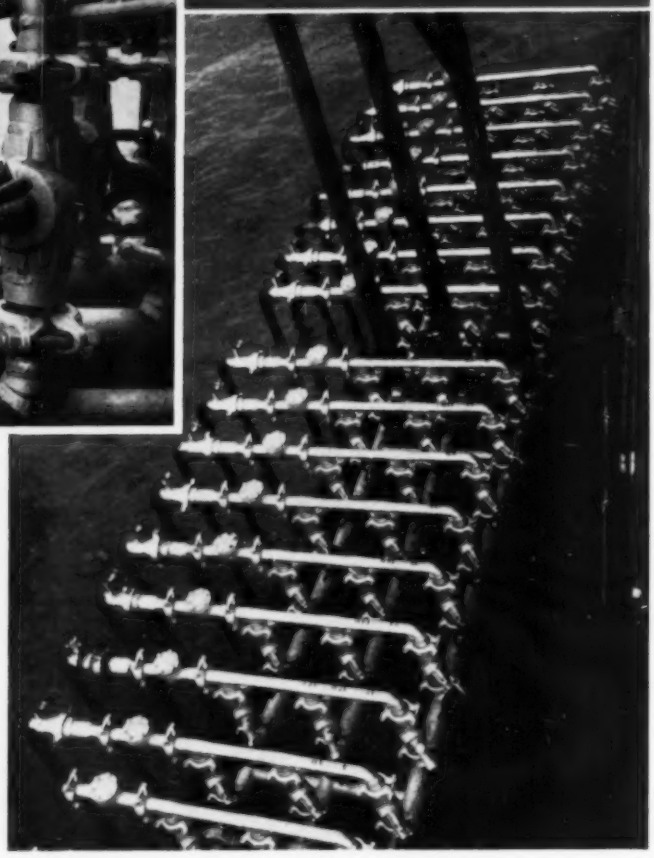

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achieve this objective led to what we call simultaneous gas-water process.[8]

In applying this idea to the propane slug process we would inject propane, follow it with a band of natural gas to miscibly push the propane, and then follow with the simultaneous injection of natural gas and water. The water and gas would be injected in a ratio to maintain a gas band back of the propane. After the injection has proceeded for some time, much of the swept reservoir will be occupied by the water and gas flowing simultaneously. Water and gas flowing simultaneously have a low mobility, much like water alone. This is so because the gas and water interfere with each other's flow (relative permeabilities of the two phases are reduced). Also, the average viscosity of the gas and water stream will be well in the direction of the viscosity of water. Both of these effects lower the mobility of the gas and water system, and a favorable mobility ratio is developed for the system. This permits the miscible displacement process to approach the sweepout efficiency of water.

Among the fine points in engineering this process is included the necessity to maintain a band of gas just back of the propane. If the water catches up with the propane, it will leave propane behind as a residual phase and destroy the slug. To avoid this, the water and gas are injected at a ratio to maintain a slight accumulation of gas ahead of the water.

We would propose this combination gas-water process for any of the gas driven miscible displacement processes. There are a few situations where it could not be used. For example, if the reservoir is very tight, it would take too many injection wells to inject the necessary volume of low mobility water-gas system. Nevertheless, in the vast majority of cases, this device should be applicable.

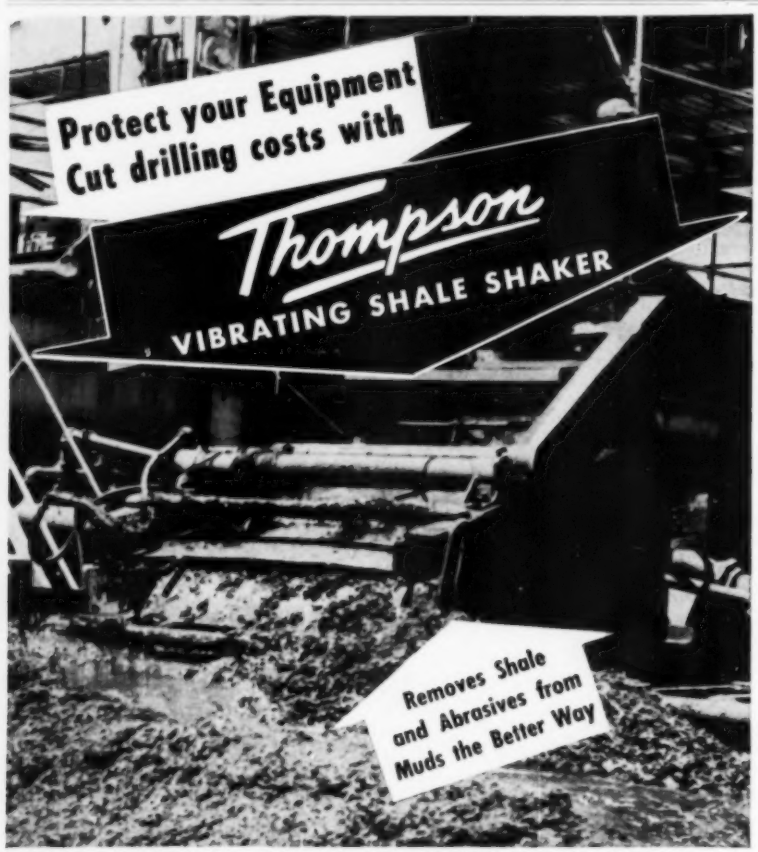
It has another merit. If something goes wrong in the miscible process to destroy the miscible band, operation will revert essentially to a waterflood.

Evaluation and Exploitation of Present Processes

The high pressure gas injection process has been in the field longer than the other processes. With nine years of operating experience in the University Block 31 operation and over three years of experience in another location, we feel that we can proceed with confidence with other applications of this process. We have ample evidence that miscibility is being developed in the reservoir and that the miscible drive is displacing oil very effectively. There has been fear in some quarters that channeling, fingering, and gravitational segregation would lead to very poor displacement sweep efficiency with this process. We now know that, at least in the type of reservoir for which we have data, these effects will not be severe. Actually we have to live with these problems in any injection process, even waterflooding.

Field tests for the propane slug process and for the rich gas drive process are not so far along. It has been established without doubt in the laboratory that miscible displacement can be obtained in the field with these processes. Also, experimental and theoretical studies have supplied a basis for making engineering estimates of the amount of LPG required for field operations. It still remains for the industry to fully evaluate the effects of realistic field flow conditions in reservoir size operations on the requirement for LPG for these processes.

Another problem that arises is to choose between waterflooding and a miscible displacement process for a given reservoir. Make no mistake; waterflooding is an excellent recovery process. We believe we know how to recover more oil with miscible displacement than with waterflooding under many circumstances, but it is



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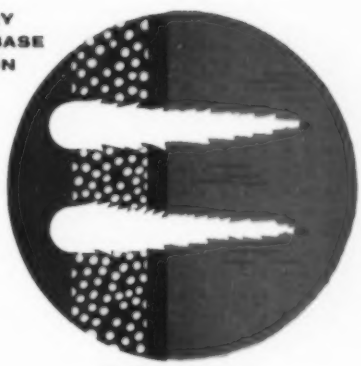

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not clear in many cases that it will be more economical to recover more oil with miscible displacement. Invariably, the miscible displacement operation requires a greater initial investment than a waterflooding operation would. A miscible displacement operation compares favorably economically with a waterflood operation in cases in which the miscible project can be operated at high rates of oil production or in which oil production rates are sustained much longer than they would be in waterflooding. This, of course, bears on the operator's getting a satisfactory return on his investment. An operator would be foolish to invest a lot more money in a miscible project than in waterflooding if the extra income he expects from doing this isn't available for 10-20 years.

A Look Ahead

Miscible displacement can be applied to watered-out reservoirs. It has been learned from laboratory research that a miscible injection operation will bank up the residual oil left after a waterflood or after a natural water-drive performance, and permit this oil bank to flow and be produced from producing wells. Although this application involves the disadvantage of requiring the production of a lot of reservoir water before oil bank is produced, it is worth considering because it is the alternative to abandoning the reservoir. It is a way to get a third crop of oil after waterflooding.

Natural gas is becoming more valuable and therefore more costly. Much of the gas injected in gas driven miscible displacement operations merely serves the purpose of filling reservoir pore space but not taking part in the actual miscible displacement. We might inject enough hydrocarbon gas to insure miscible displacement and follow this with the cheap gas to fill up pore space. A cheap gas that might be used is flue gas,[9] a mixture of nitrogen from the air and carbon dioxide. Flue gas can be made relatively inexpensively.

Flue gas may also be considered for direct miscible displacement merely by operating at higher pressures than with hydrocarbon gas. Or flue gas can be used to miscibly push a slug of LPG intermediates through the reservoir.

One limitation of all hydrocarbon miscible processes described is that they must be operated at pressures of 1000 psi or greater. This is because natural gas is involved at one of the miscible fronts, and pressures of this order are required for gas-hydrocarbon fluid miscible displacement. An intermediate material is needed to place as a slug between water and oil so that the process can operate at lower pressures. For example, if cheap enough, alcohol would be a suitable agent.

Whatever process comes along, it will likely not be a panacea. We shall gradually develop an array of processes to cover the variety of situations that exist. Waterflooding will still be fashionable in some areas ten years or more from now notwithstanding new developments. Likewise, miscible displacement will be an important process, but not the only one, for a long time.

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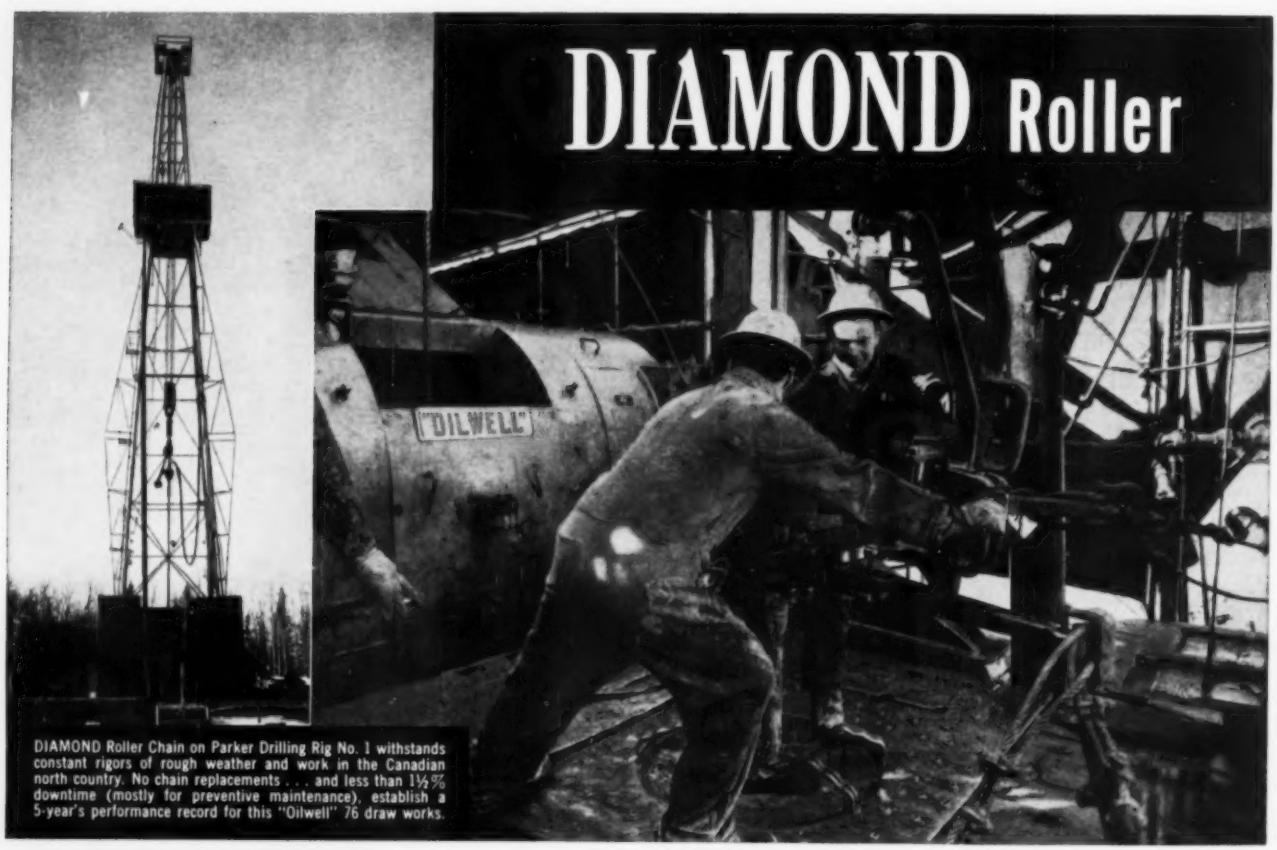

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THE OASIS—

A gathering spot for NOMADS

Los Angeles: Shown between Taylor Bannerman of Technical Oil Tool Corporation, Ritual Master (left) and Lee Laird of Ladish Company, Assistant Ritual Master (right) are new members of the Los Angeles Chapter of Nomads who were inducted at the June 10, 1959, meeting of the chapter. They are John Cochran of Drilltrol, Regular; Neal Thompson of Ken Corporation, Regular; Louis Smith of Chiksan Company, Regular; Bob Thompson of Servco Corporation, Associate; Joe Douglass of Gardner-Denver Company, Regular; and Clayton Rose of Monarch Engineering Company, Regular.

NOMADS CHANGE MEETING PLACE

The meeting place of the Los Angeles Chapter of Nomads is now the Biltmore Hotel.

Houston: Five new members were inducted into the Houston Chapter of Nomads at the chapter's regular June dinner meeting. The inductees, in full regalia, from left to right: Charles A. Doh, Schlumberger, W. B. Colvin, Texsteam, Roscoe Dickey, Magcobar, Nelson Bigelow, World Oil and F. O. Richards, Udell, Inc.

NOMADS MEETING DATES AND SECRETARIES

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 903, 45 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday, Ye Old College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18171, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Biltmore Hotel, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 3771, Tulsa 9, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Tex.

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RUNNING TOUR with MEN in the INDUSTRY

K. E. Rotegard, Gulf Oil's district manager at Amarillo, Texas, has been named financial and services coordinator of the domestic production department. He succeeds **Raymond K. Pearson** who has been transferred to the company's general offices in Pittsburgh as assistant comptroller.

George C. Hardin Jr. has been promoted to general manager of all of the Michel T. Halbouty oil and gas activities. **Thomas D. Barber,** assistant division exploration superintendent for Pan American Petroleum Corporation, has joined the organization as manager of exploration, supervising all geological, geophysical and land matters.

The West Texas-New Mexico division exploration office of Kerr-McGee Oil Industries, Inc., was expanded to include the Panhandle district, and its location is being moved to Amarillo, Texas. The former division office was at Midland, Texas. **Jere McKenny,** formerly Mid-Continent district geologist in the Oklahoma City headquarters office, has been named manager of the division. **Stan Hardison** continues as Panhandle district geologist. Other geologists in the division office will include **William V. Harlow, Donald Fish** and **Charles Hassenfratz. Curtis Regan,** formerly at Midland, continues as division landman. **M. H. Vaughn,** geologist formerly assigned to the Panhandle district, remains located at Amarillo, but is not a part of the new division office, reporting directly to chief geologist **John Masters.**

Prentice R. Watts, Jr. has been promoted to general superintendent of Aztec Oil & Gas Company. He will be in the home offices in Dallas. Watts, a petroleum engineer, has been in charge of the company's Hobbs, New Mexico, district for the past 9 years. **Lester L. Duke,** geologist, replaces Watts. He has been in the Hobbs district the past 4 years. **John Elliott,** geologist, was transferred from Dallas to Hobbs.

P. R. Watts, Jr.

H. J. Gruy

H. J. Gruy has been elected president of H. J. Gruy and Associates, Inc., with the recent incorporation of the consulting petroleum and geological engineering firm, and the company has moved into expanded quarters in the Southland Center in Dallas. Other officers elected were **Irene Haskett, C. M. Netherland** and **Arthur Wessely,** vice presidents; and **William K. Horn,** secretary-treasurer.

William A. Boyd, president of The Kimbark Company of Denver, Colorado and **Walter K. Arbuckle,** president of Kimbark Exploration Company, have announced the formation of a new corporation owned by The Kimbark Company stockholders and former employees of The Kimbark Company. The new corporation, Kimbark Exploration Company, has assumed all exploration, drilling, lease development, and producing functions formerly engaged in by the company and will operate Kimbark Company lease interests and drilling operations in Colorado and Kansas.

Officers are **Walter K. Arbuckle,** president; **William R. Thurston,** vice president-exploration; and **C. Crady Davis,** vice president and treasurer.

Jack W. Boone has joined Fred L. Oliver & Associates, a petroleum engineering consulting firm in Dallas, Texas. He will work primarily in reservoir engineering, a field in which he has specialized for several years. Boone has worked for 2½ years as petroleum engineer for Stephens Oil & Gas Corporation in Lubbock, Texas.

Anthony E. L. Morris has been appointed manager of exploration for Pauley Petroleum, Inc., and its subsidiary companies. He moves to this position following 2½ years in Jordan as Middle East manager for the company.

Thomas H. Hurley Jr., has been named training representative for Sunray Mid-Continent Oil Co.'s production department. Hurley previously was with Shell Oil from Midland, Texas.

Harold Svoboda, manager of production, has been elected vice president of Sunset International Petroleum Corporation. Mr. Svoboda, who will continue to be in charge of all oil and gas production, joined the company as a petroleum engineer 7 years ago.

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with Metal-to-Metal Seal and a Compressed Soft Seal
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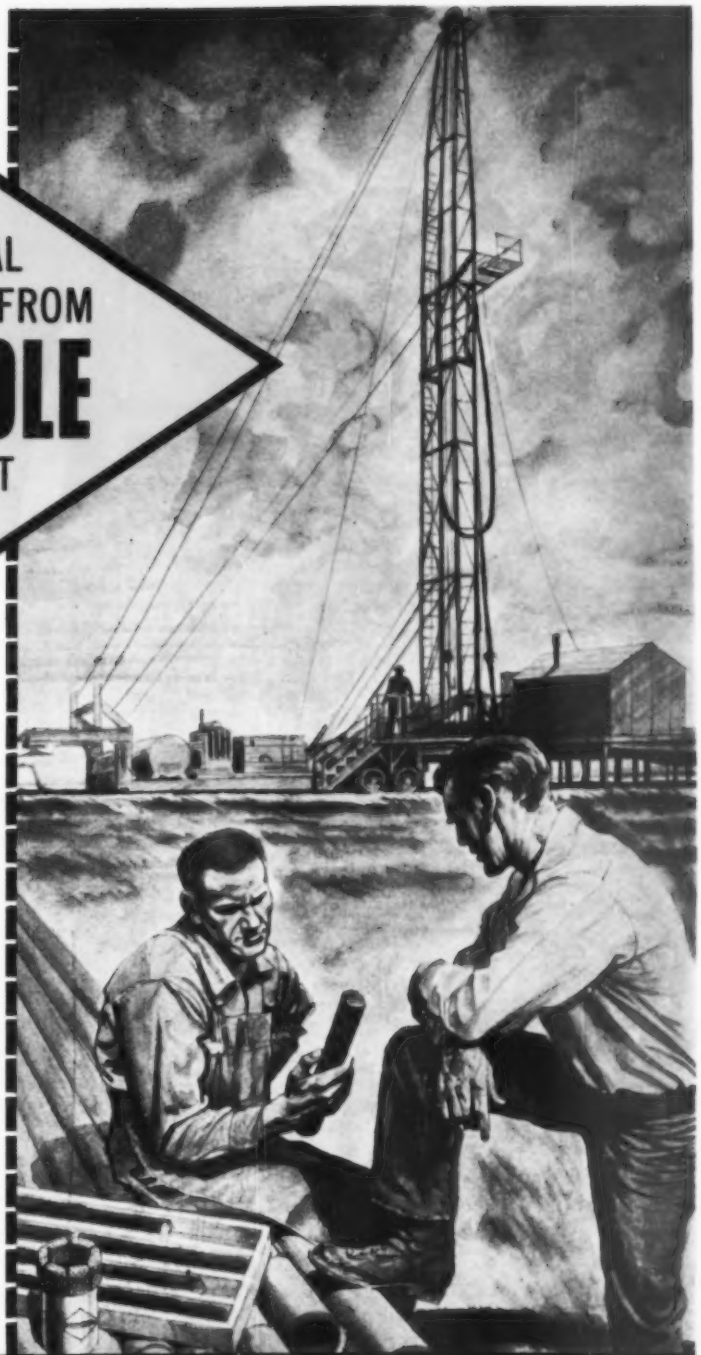
DIAMONDS MEAN...

ECONOMICAL PERFORMANCE FROM SLIM HOLE EQUIPMENT



There is a need for a cheaper way to find oil, and slim hole drilling seems to be one answer. Over-all well costs are lower, and well completion costs are considerably less. The use of diamond bits with economical slim hole equipment provides even greater savings — especially in a deep hole operation. Recent successes have further upheld this idea. The diamond bit, having no moving parts, achieves maximum footage and longer bit life, even with the higher rotational speeds common in slim hole drilling. By its ability to stay on bottom in hard formations, the diamond bit reduces costly round trips. The excellent cutting action of diamonds is equally good in large or small bits, and, as the cost of a diamond bit depends on the carat weight of the diamonds, the smaller slim hole bits will cost less.

The quality features of Christensen standard core barrels are incorporated in our special 3½" x 1¾" slim hole barrel. Our hydraulic wireline core barrel is also available for slim hole drilling. Remember, for your slim hole job, Christensen diamond bits and core barrels mean "Less Cost Per Foot."

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"BEST PUMPS IN THE OIL PATCH"

Running Tour

Dewey G. McKinney has been appointed district landman for the Midland district offices in Midland, Texas for Cabot Carbon Company. He was formerly a staff landman in the Pampa district office at Pampa, Texas, and replaces **M. W. Rafferty** who was recently appointed district landman for Cabot's new Denver district office at Denver, Colorado.

Paul D. Balbin has been promoted to general manager of Chaco Petroleum, S. A., Bolivian subsidiary of Tennessee Gas Transmission Company. Balbin, who has been employed as chief geophysicist for Chaco since March 1958, will have headquarters in Cochabamba, Bolivia. He succeeds **W. B. Tapper,** who resigned recently.

Harold L. Briggs of Los Angeles, executive vice president of Coline Gasoline Corporation and vice president of Chanslor-Western Oil and Development Company, wholly-owned affiliated companies of the Santa Fe Railway, has retired. **John L. Stephens,** assistant to the executive vice president, succeeds Briggs.

R. B. O'Connor has been named area geophysicist in Shell Oil Company's Houston area exploration department. He succeeds **G. F. Pirsig,** who will go to Shell Oil Company of Canada, Ltd., in the same capacity.

Four changes in Shell Oil's Houston area land department are: **J. M. Roberts,** area land agent in Houston, takes a similar position in the New Orleans area; **W. W. Welch,** East Texas division land manager, will serve as area land agent until a permanent successor for Roberts has been selected. **W. R. Kemper,** Corpus Christi division land manager, takes a special assignment on the company's head office exploration department staff in New York. **E. R. Godbout,** area land agent in Midland, succeeds Kemper.

J. W. Pittman was named transport and materials manager in the New Orleans exploration and production area. Pittman succeeds **K. W. Martin** who has been named manager of the newly created administrative services department in the company's head office, New York. **W. M. Johnson,** assistant to the vice president in New Orleans, has retired.

O. L. Odale, production manager for Shell's Denver area, has been named production manager for the Pacific Coast area. He succeeds **W. F. Bates** who has been placed on special assignment on the staff of the vice president for this area. **J. W. Inkster,** exploration manager in Tulsa, will move to Houston in the same capacity. He replaces **M. S. Metz** who will be on special assignment with Shell's head office exploration organization. **R. L. Trott,** executive assistant to the vice president, Tulsa area, will assume a similar position in the Houston area. In Houston **Dr. H. T. Byck,** formerly assistant to the vice president, has been named manager of administration and services. He succeeds **Frank Goldstone,** who will undertake a special assignment for Shell Oil Company's exploration department. **Barclay Van Dyke** and **W. L. McKinnon** were named assistant managers of the administration and services department, each with responsibility for a number of laboratory functions. **Dr. Gordon Rittenhouse,** manager of the geology department in the laboratory's basic research section, was named consultant in geology to the laboratory staff. Succeeding him as geology department manager is **Dr. D. V. Higgs,** now a geologist in the basic research section.

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▸ **J. D. Lindner** has joined Norman J. Clark Engineering, Dallas-based firm. He will be a senior associate engaged in reserve and valuation studies of primary and secondary projects including waterflooding and miscible drive.

▸ **H. E. Prokesh** has been promoted to manager of exploration for Continental Oil Company's southwestern region. Formerly regional geophysicist, he continues at Fort Worth and will succeed **J. E. Finley,** who will be on a leave of absence from Conoco for one year while attending the Massachusetts Institute of Technology under the Sloan Fellowship Program.

It was announced at the same time that **G. H. Swenumson,** Roswell, N. M., division geophysicist for Conoco, has been promoted to replace Prokesh. **V. H. Waddell,** Midland, Tex., geophysical supervisor, succeeds Swenumson, at Roswell. **R. L. Adams,** Roswell, New Mexico, has been promoted to manager of production for Continental Oil Company's CATC marine region, with headquarters in Houston. He succeeds **S. V. McCollum,** who recently resigned to become manager of offshore operations for Tennessee Gas & Oil Company, a division of Tennessee Gas Transmission Company. Adams was formerly production superintendent of Conoco's Roswell division.

▸ **Dr. Sylvain J. Pirson,** University of Texas petroleum engineering professor and authority on reservoir engineering, conducted two short courses on well logging in England and Italy. Dr. Pirson gave the first course in London June 8-19 for representatives of oil companies from the Middle East. Engineers and geologists from Iraq, Kuwait, and other countries in the Persian Gulf area participated. From June 29 to July 10 he was in Milan to present a similar course to Italian petroleum engineers.

▸ **Dr. Robert R. Wheeler,** consulting geologist, has opened offices at 190 Meadows Building, Dallas, Texas, for independent operations, including domestic and foreign exploration.

▸ **J. L. Stauss,** vice president and treasurer of Falcon Seaboard Drilling Company, Tulsa, has been named vice president of the American Association of Oilwell Drilling Contractors for the Mid-Continent area. Stauss replaces **F. G. McClintock** who formerly was president of Zephyr Drilling Co. and is now associated with the First National Bank and Trust Co. of Tulsa.

▸ **D. R. Moreland** has joined Bart De Laat and Associates, consultants in petroleum and natural gas.

▸ **Kirby Hillin** has been appointed as assistant division civil engineer of Sun Oil Company's Southwest division. Formerly a regional civil engineer, Hillin will continue to work closely in the Dallas offices with Division Civil Engineer **Arch Clark. Cecil A. Colville** of Midland, Texas, was named administrative assistant to the management, southwest production division in Dallas. He has been district operating superintendent for the Midland district and his successor in that position at Midland is **E. Lloyd Kownslar,** formerly assistant district superintendent at Corpus Christi, Texas. **Jake B. Higginbotham,** area superintendent at Robert Lee in West Texas, moves to Corpus Christi to succeed Kownslar. **Robert K. Beggs,** assistant area superintendent in charge of the Gainesville Area in North Texas, replaces Higginbotham. **Claud W. Underwood,** assistant district superintendent at McAllen in the Rio Grande Valley, now is in charge of the Gainesville area. **Cleo Alexander,** area superintendent at Sun Field in Starr County near the Rio Grande, moves into the McAllen district office to succeed Underwood as assistant district superintendent. **Frank A. Lawrence,** assistant to the regional superintendent in the Dallas office, succeeds Alexander.

William R. Gannaway was named assistant division chief geologist for Sun Oil's Mid-Continent production division. **Robert L. Kelley** has been appointed coordinator of production accounting. In 1958 he joined the comptroller's staff in the Philadelphia general offices, the position he held prior to his present assignment.

▸ Diversa, Inc., has announced the opening of two new district offices, and has engaged two new geologists to direct them. **Jack Reed** has been appointed district geologist for the Midland, Texas, office. He previously was a division geologist for Pan American Petroleum in West Texas. He has also been a consulting geologist. **Ralph Storm** has been appointed district manager of all of West Texas which will be directed from executive offices in Dallas. **Douglas D. Howard** is the new district geologist for Tennessee-Kentucky area. **Roy D. Garner** was named district manager of South Louisiana area operations with offices in the Shell Building in New Orleans. **Frank G. Spain** was named district landman at New Orleans. He was affiliated with the Huber Company in West Texas and North Dakota.

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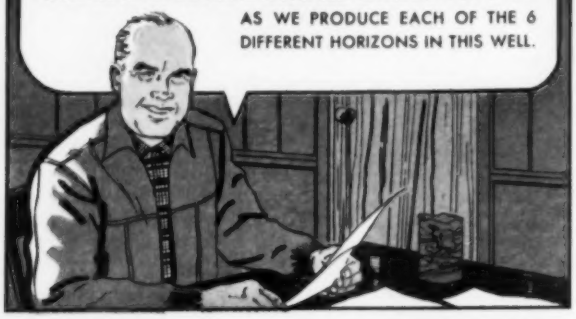
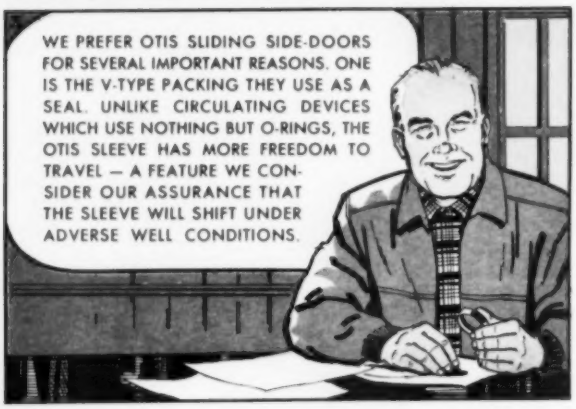
WILL SAVE US SEVERAL HUNDRED DOLLARS PER ZONE

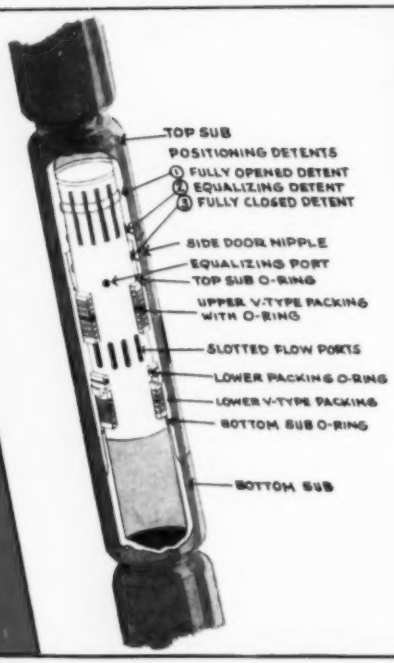
AS WE PRODUCE EACH OF THE 6 DIFFERENT HORIZONS IN THIS WELL.



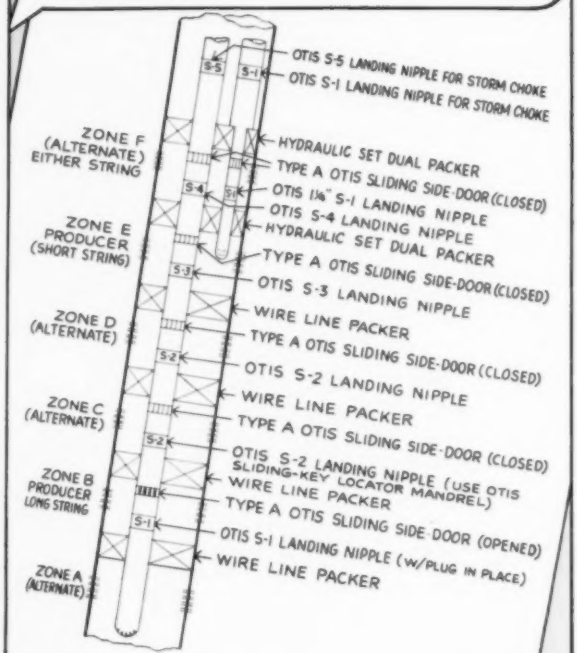
WE PREFER OTIS SLIDING SIDE-DOORS FOR SEVERAL IMPORTANT REASONS. ONE IS THE V-TYPE PACKING THEY USE AS A SEAL. UNLIKE CIRCULATING DEVICES WHICH USE NOTHING BUT O-RINGS, THE OTIS SLEEVE HAS MORE FREEDOM TO TRAVEL — A FEATURE WE CONSIDER OUR ASSURANCE THAT THE SLEEVE WILL SHIFT UNDER ADVERSE WELL CONDITIONS.



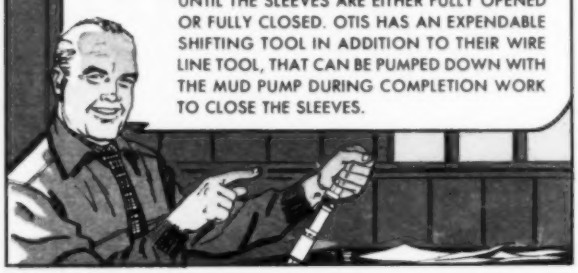
THEN THERE'S OTIS' VERTICAL SLOTTED PORT DESIGN. THIS GIVES OTIS SLIDING SIDE-DOORS MAXIMUM STRENGTH—AND ACTS TO PREVENT DISTORTION OF THE TOOLS AS THEY ARE SUBJECTED TO THE STRESS AND TORQUE OF A PRODUCTION STRING. HERE'S A DETAILED DRAWING OF THE TYPE A OTIS SLIDING SIDE-DOOR. NOTICE THE DESIGN ADVANTAGES.



ADD TO THAT THE THOUSANDS OF DOLLARS WE SAVED BY DRILLING ONLY ONE WELL TO PRODUCE THESE 6 FORMATIONS AND YOU'LL SEE WHY WE'RE SOLD ON MULTIPLE-ZONE WELLS AND OTIS SLIDING SIDE-DOOR EQUIPMENT. HERE'S A DIAGRAM OF THE WELL.


OTIS S-5 LANDING NIPPLE FOR STORM CHOKE
OTIS S-1 LANDING NIPPLE FOR STORM CHOKE
ZONE F (ALTERNATE) EITHER STRING
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS 1¾" S-1 LANDING NIPPLE
ZONE E PRODUCER (SHORT STRING)
OTIS S-4 LANDING NIPPLE
HYDRAULIC SET DUAL PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-3 LANDING NIPPLE
ZONE D (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE
ZONE C (ALTERNATE)
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (CLOSED)
OTIS S-2 LANDING NIPPLE (USE OTIS SLIDING-KEY LOCATOR MANDREL)
ZONE B PRODUCER LONG STRING
WIRE LINE PACKER
TYPE A OTIS SLIDING SIDE-DOOR (OPENED)
OTIS S-1 LANDING NIPPLE (W/PLUG IN PLACE)
ZONE A (ALTERNATE)
WIRE LINE PACKER

ANOTHER ADVANTAGE OF THIS OTIS EQUIPMENT IS THAT WITH THEIR SHIFTING TOOL THEY CAN OPEN AND/OR CLOSE ONE OR SEVERAL SLEEVES WITH JUST ONE TRIP OF THE WIRE LINE. AND YOU'RE SURE THE SLEEVES ARE FULLY SHIFTED, TOO. OTIS' SHIFTING TOOLS WON'T RELEASE UNTIL THE SLEEVES ARE EITHER FULLY OPENED OR FULLY CLOSED. OTIS HAS AN EXPENDABLE SHIFTING TOOL IN ADDITION TO THEIR WIRE LINE TOOL, THAT CAN BE PUMPED DOWN WITH THE MUD PUMP DURING COMPLETION WORK TO CLOSE THE SLEEVES.



WE HAVE TRIED OTHER CIRCULATING VALVES AND "SUBSTITUTE" TOOLS, BUT RAN INTO TROUBLE OR FOUND THAT WE DIDN'T HAVE THE VERSATILITY NEEDED TO DO THE JOB. CONSEQUENTLY, WE PREFER AND USE OTIS SLIDING SIDE-DOORS. IF YOU NEED CIRCULATING TOOLS, I SUGGEST YOU CALL OTIS AND GET THE BEST!

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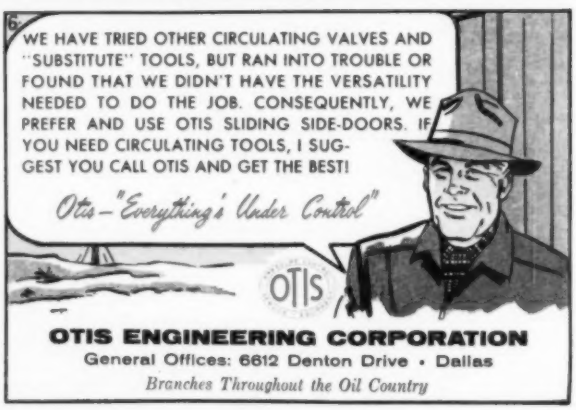

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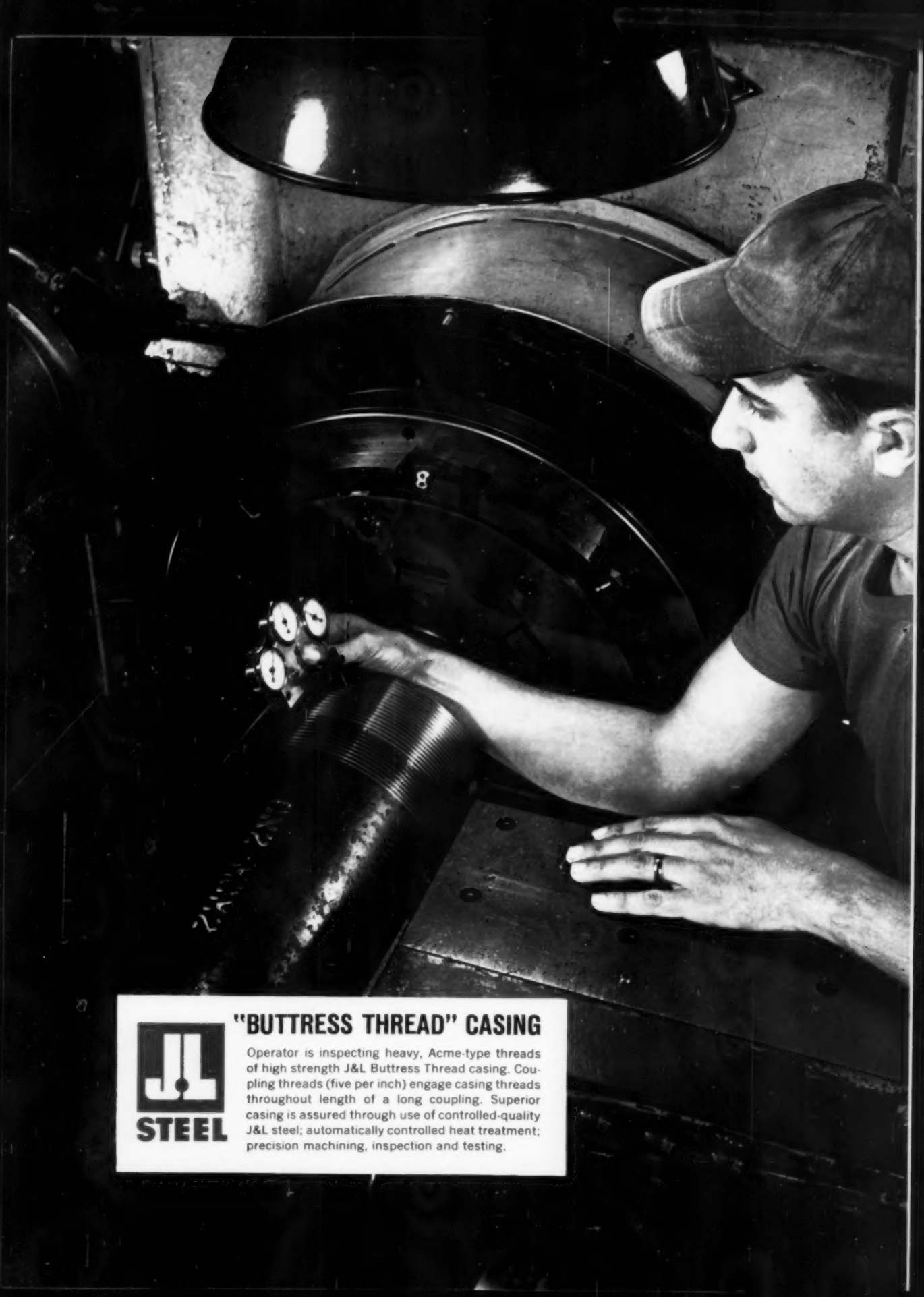

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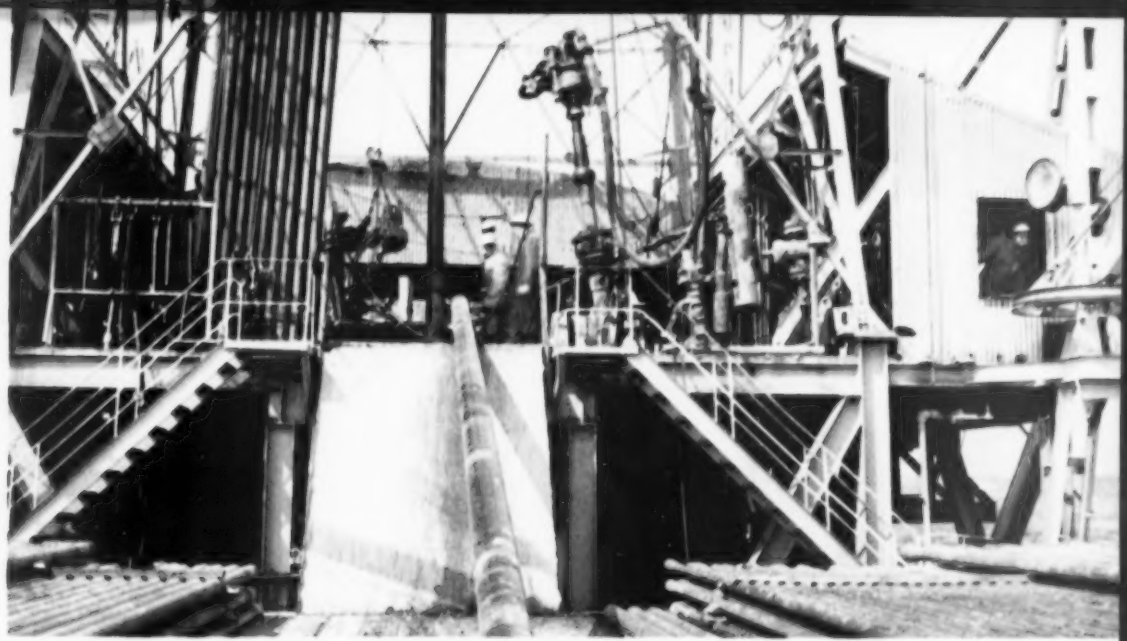

Bell Isle Corporation No. 43 well, located southwest of Morgan City, Louisiana.

"High strength J&L Buttress Thread casing in top sections permits running a longer, heavier intermediate string"

. . . says Sun Oil drilling superintendent

Sun Oil used 5813 feet of Buttress Thread casing in the top sections of the 9⅝" casing in this Bell Isle Corporation No. 43 well near Morgan City, Louisiana.

"The high strength J&L Buttress Thread casing was used so a much longer and heavier intermediate string could be run," according to the drilling superintendent.

"The top 2297 feet of 9⅝" casing was 47 lb. N-80, R-3 J&L Buttress Thread. The next 3516 feet of 9⅝" casing was 43.5 lb. Buttress Thread."

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Top 5813 feet of 9⅝" casing in this new well was high strength J&L Buttress Thread casing. Well was drilled to 14,320 feet by the Sun Oil Company. Diesel Electric Drill Barge No. 2 handled the job.

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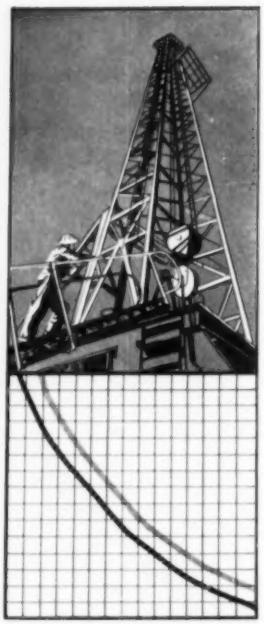

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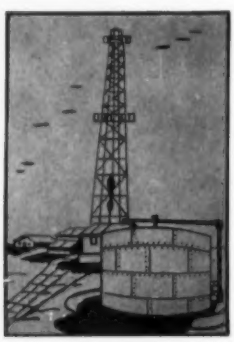

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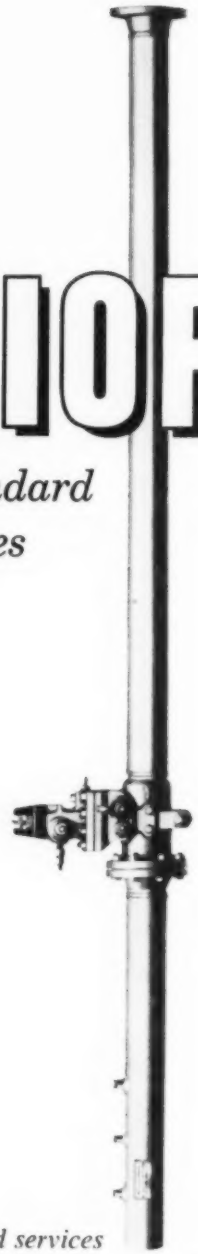

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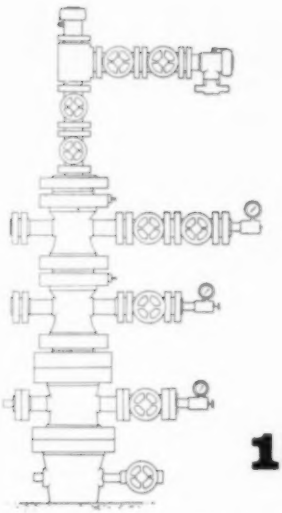

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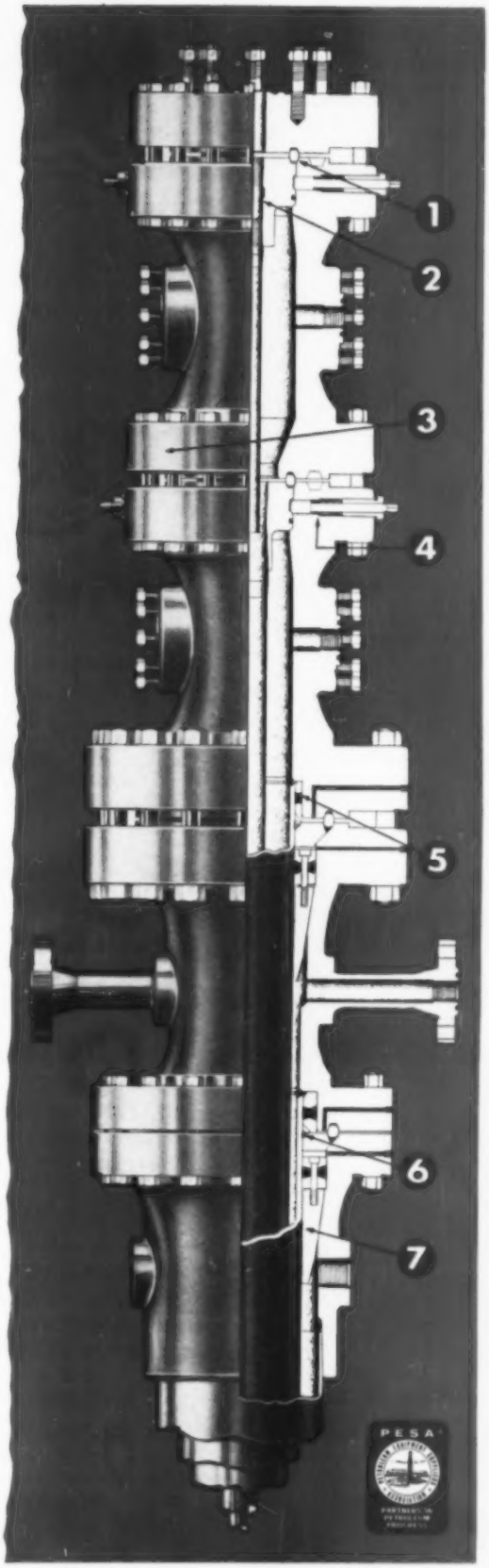

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EXPLORATION ACTIVITIES

SPAIN

Deepest Well Stopped; Other Tests Continue

The exploratory well Alda 1, drilled by the Spanish-German consortium Ciepsa-C. Deilmann, located 20 miles east of Vitoria in northeast Spain, has been stopped at 16,474 ft.

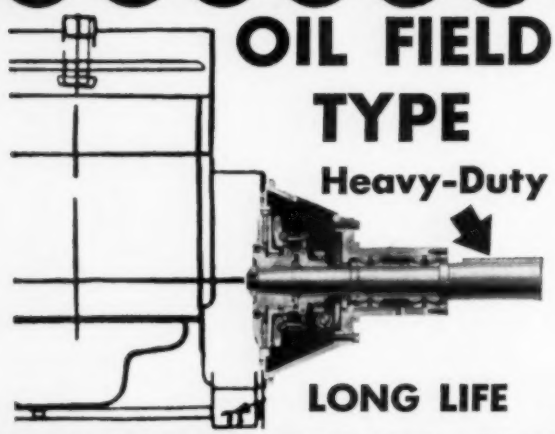
Alda is one of Spain's deepest wells drilled for geological exploration purposes. The installation of a 6⅝-in. string at a depth of 14,000 ft furnished the pre-requisite for reaching the total depth. Gas indications were encountered at various depths and will be investigated further.

Under the Ciepsa-Deilmann cooperative program, two other rigs are drilling, one at Treveno, the other at Alloz. The well Treveno 3 has reached a depth of 10,000 ft; the Alloz 1, 4130 ft.

ROCKFORD

OIL FIELD TYPE

Heavy-Duty



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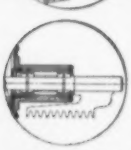
POWER TAKE-OFF

➡ Eliminates Out-Board Bearings and Couplings

The heavy-duty construction of ROCKFORD Oil-Field type POWER TAKE-OFF bearing assemblies will handle side loads that formerly required the use of out-board bearings—with hangers and flexible couplings.



Shaft deflection is no problem with this extra heavy-duty power take-off—when the load is held within specifications. You can reduce the over-all length of the engine and power take-off assembly by specifying ROCKFORD.

BW SEND FOR THIS HANDY BULLETIN

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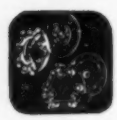

Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

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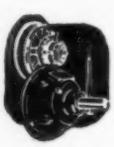

Power Take-Offs

Speed Reducers

CLUTCHES

MICHIGAN

Scipo-Albion Trend Play Heightens Tri-State Activity

The Scipo-Albion Trend area in South Central Michigan now is seeing one of the most active leasing and drilling plays in the Tri-State area. The petroleum pools on the trend produce from the Trenton dolomite formation. Wells along this trend can produce 150 bbl per day each day of the month.

Acquisition of 4057 acres of oil and gas leases in five separate spreads on the Scipo-Albion Trend in Calhoun County by Texas American Oil Corporation puts this company in the play.

The trend runs southeast to northwest. Prolific producers recently have been found along it with some of them flowing at the rate of 800 bbl an hour. A recently completed one and one-half mile extension to the proved area, located just west of the town of Albion, flowed 200 bbl of oil hourly.

Texas American's acreage is in the Eastern Convis Township and portions of the Lee, Albion, Sheridan, and Marengo townships. Approximately 2000 acres of its newly acquired leases are immediately north of the Thomas Mask No. 1 Flynn in the southeast quarter of Section 6, Marengo Township, an active wildcat now drilling below 3000 ft and projected to a depth of 4100 ft to test the Trenton horizon.

Texas American will soon drill at least one well on the trend.

ALGERIA

Phillips, Partners Gain New Sahara Permit

Phillips Petroleum Company and its French partners have been awarded another exploration permit in the Sahara Desert of Algeria. The new concession, known as Hassi Chaambi, is 390 miles south of Algiers and some 60 miles southwest of the Hassi Messaoud oil field. It includes 148,262 acres which adjoin the southern boundary of the previously awarded El Morr exploration permit, and increases the area of that block to 469,492 acres.

Phillips will have a 25 percent interest in the new permit and is associated with two French Companies, COPEFA (Compagnie des Petroles France-Afrique) and OMINIREX (L'Omnium de Recherches et Exploitations Petrolieres). COPEFA will be the operator.

This new acquisition brings Phillips' holdings in the Algerian Sahara to 1,455,852 net acres in 4,145,105 gross acres.

TEXAS

Pan Am to Try for Frio Production at La Marque Test

Pan American Petroleum Corporation has spudded a 15,000 ft Galveston County wildcat attempt to find new deep Frio production north of Hitchcock field in the Hastings area.

Pan American No. 1 Stewart Title Guaranty Company is one-half mile north of the Hitchcock production, inside the city limits of La Marque, Texas. At its projected total depth, the test will be the deepest within several miles of its location.

The location is spotted 25 ft from the southeast corner of lot 18, block U of Cook and Stewart subdivision in La Marque, about 7450 ft west of the east line of J. D. Moore Survey A-150.

New Gas in Lower Frio Found Near Bay City

MPS Production Company and Van Dyke & Mejlaender, Houston independents, have potentialed their No. 1 Violet Creech, a Matagorda County gas discovery six miles northeast of Bay City.

From perforations at 9520-30 ft in the Lower Frio the well had a calculated open flow potential of 27,000,000 cu ft per day and a gas-oil ratio of 73,400 to 1. In a test on a 13/64th-in. choke the wildcat produced at the rate of 3,080,000 cu ft daily with shut-in tubing pressure of 3278 psig, a flowing pressure of 3190 psi, and a bottom hole shut-in pressure of 4153 psi.

The deeper pool wildcat, a subsurface geological prospect, is across a fault from the Sugar Valley field a half mile to the northeast. Van Dyke & Mejlaender is a partnership organized last November consisting of geologists Gene Van Dyke and Georg O. Mejlaender.

Marion County Completion Try Set in Lower Pettet

Completion operations are underway on Trice Production Company's No. 1 Davis-Pelphrey, an East Texas new-pay wildcat on the south perimeter of Ferrell's Lake field in Marion County.

The No. 1 Davis-Pelphrey, one and one-half miles south of field production limits, has discovered oil in the Lower Pettet in a zone whose top is at 7436 ft. Previous production in the field has been from the Upper Pettet. Trice's well is located on the south side of the lake, across the water from present field production limits.

BETTER BALANCE ... at any depth!

The deeper your well, the more important correct counterbalance becomes.

Even small changes in well conditions can result in power waste and unnecessary wear and damage to equipment if a pumping well is not properly balanced.

With a JENSEN Rotary Balanced JACK the adjustment of the counterbalance is such a simple one-man job there is no excuse for any well ever being improperly balanced — whether it is deep or shallow.

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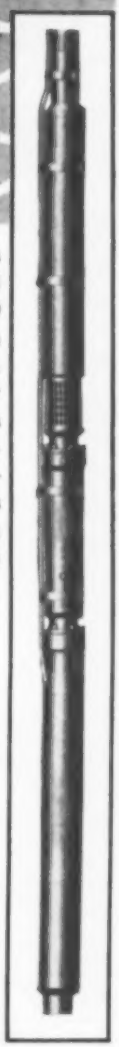
Choose ... REDA

PUMPS FOR HIGH WATER-OIL RATIO WELLS



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INCREASE YOUR *PROFITS* WITH REDA SUBMERGIBLE ELECTRIC PUMP ADVANTAGES:

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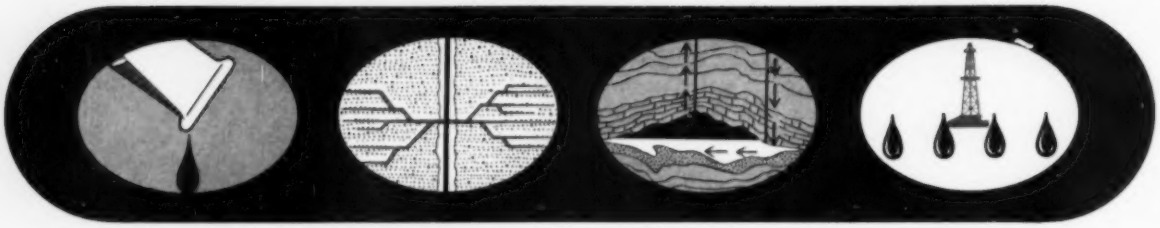
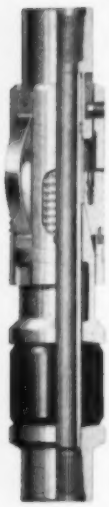


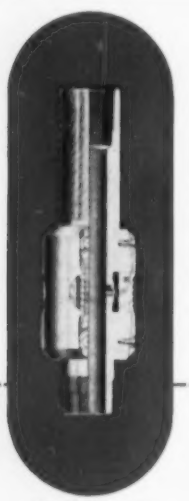


HALLIBURTON'S R-3 TREATING PACKER!

has UNEQUALLED VERSATILITY

EFFICIENT VERSATILITY. . . A short, compact, retrievable packer designed for use in treating, fracturing, water flooding or producing wells. Simple in design . . . easy to operate, low in cost . . . may be set and re-set as many times as desired on one trip in hole, or moved from well to well. Redressing and replacement of parts is simple. The full opening R-3 packer permits passage of wireline tools, instruments or perforating guns. A built-in safety joint allows tubing to be removed . . . is easy to drill out, if conditions prevent normal removal.

ESPECIALLY USEFUL IN SHALLOW OR LOW-FLUID WELLS . . . Run primarily as an upside-down hook wall packer; the R-3 is self-anchoring with no tubing hold down required when run as a tension packer. The packer seal rubbers are available in different durometer hardness to suit various conditions.



Round Slip Type

THE HALLIBURTON HYDRAULIC TUBING HOLD DOWN . . . Used with R-3 Treating Packers when set in compression helps prevent upward movement of the tubing caused by the lifting force applied below the packer. The holding power of the tubing hold down is proportional to the lifting force. Halliburton Hydraulic Tubing Hold Downs are available in two types: Round Slip Type and Long Slip Type. Both have identical features, except the Long Slip Type has rectangular slips with greatly increased area for maximum holding power. The setting and releasing of the slips are controlled by tubing pressure in each; both incorporate case hardened slip wickers, fishing neck on top of tool, durable synthetic rubber seal pads, and are easily serviced.

The R-3 Treating Packer is available in 4½", 5½" and 7" O.D. casing sizes. Get this versatile, economical tool from any Halliburton Representative.

Long Slip Type

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CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY
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284 SERVICE CENTERS—JUST MINUTES AWAY FROM YOUR WELL

CANADA

Canada Southern Makes Northwest Territories Exploration Pact

A large transaction of untested oil and gas lands in Canada's Northwest Territories has been concluded by Canada Southern Petroleum Ltd., resulting in an agreement with Home Oil Company, Ltd., Signal Oil & Gas Company, Kern County Land Company, Alminex Limited and United Oils Limited. It provides for the latter companies to pay $3,500,000 and conduct a five-well exploratory program in exchange for exploration rights on 1,224,050 acres in the Northwest Territories. The properties currently are held under petroleum permits by Canada Southern and its partners, Magellan Petroleum Corporation and Oil Investments, Inc.

The agreement calls for the purchasing companies to invest at least an additional $3,000,000 in drilling and exploration work over the next five years in return for which they are to receive a 50 percent interest in the properties.

The property includes much of the newly-mapped North Petitot structure, a feature said to cover some 160,000 acres, located in the extreme southwestern portion of the Northwest Territories near the Yukon-British Columbia boundary.

As regards the program of exploration drilling contemplated by the agreement, the purchasing companies, with Home as the operator, are required to drill a minimum of five exploratory wells to known producing horizons of the main leasehold area. The agreement provides that the work be completed within five years.

MONTANA

Richey Pool Extended With 1060 BD Well

Ambassador Oil Corporation and Texota Oil Company have completed an important extension to the Richey Pool, McCone County.

The well, the No. 1 Schrock, is located in Sec. 26-27n-49e, and flowed 1060 bbl of 38 deg oil in 24 hours on initial potential test. Flow was through a 28/64-in. choke from open hole at 7045 to 7070 ft in the Charles D-3 Zone after treatment with 500 gal of mud acid. Shut-in pressure was 1175 psi.

The well has two pay zones, the B-1 and B-2, behind the pipe. The two zones were drillstem tested from 6890 to 6940 ft and 4500 ft of free oil was recovered.

A southwest diagonal offset, the No. 2 Schrock, is now drilling under surface pipe.

OHIO

Medina County Gas Find Prompts New Wildcat

Significant discovery of a new natural gas producing horizon in Medina County recently has prompted the drilling of a second deep test well in the area.

The new well will be located four miles southwest of the first well, where gas was discovered at a depth of 5800 ft in Dolomite, near the Cambro-Ordovician contact.

Ohio Fuel, the East Ohio Gas Company of Cleveland, and the Wiser Oil Company of Sistersville, West Virginia, are participating in the test. Delta Drilling Company of Pittsburgh has contracted to drill the well using rotary tools.

The new test is the Margaretha E. Warner No. 1 in Granger township, about seven miles east of Medina. The first well was drilled on the Frank L. Smith estate in Hinckley township.

Production of the Hinckley well was gaged at 1,210,000 cu ft open flow with bottomhole pressure of 2100 psi.

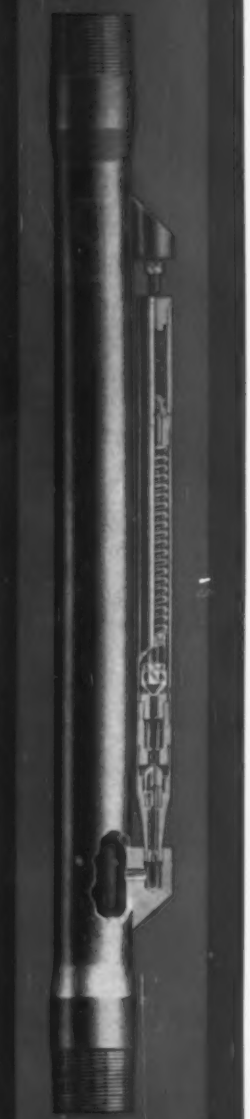
Before the Hinckley township well was drilled, nearly all drilling in Medina County had been to the Clinton sands at depths of about 3500 ft.

MERLA'S

LM

continuous flow gas lift valve

- Wide throttling range
- Eliminates need for positive choke
- Automatically proportions gas into flowing column as needed.
- Not affected by well temperatures.
- Small running diameter — ideal for many dual completions.



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manufacturers of oil tools and gas lift equipment

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Ask Me A Question

Average permeability and porosity? Solution drive recovery? Present net worth of producing properties? Optimum well spacing conditions? Effectiveness of water influx? Oil gravity after multiple-stage separation?

Big questions deserve big answers. So, meet the latest addition to Core Lab's data processing center — IBM 650.

No mere calculator, the 650 can retain 20,000 digits of information (including Core Lab's vast storehouse of reservoir knowledge), remember instructions, and follow them with logical ability as it adds, subtracts, multiplies, and divides.

Put into service only recently, the system has already indicated the attainability of many new horizons of reservoir data application — a clean break through the barrier of manual limitations.

Whether your well or field problem involves the use of basic or special core analyses, fluid analysis, secondary recovery investigation and planning, reserves study and evaluation, or pure research, Core Lab's 650 now contributes its sophisticated talents to the project.

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CALIFORNIA

Union Finds Lower Producing Zone in Bridge Field Extender

A deep-test extension well flowing 33 deg crude at the rate of 1200 bbl a day has been completed in the Bridge field south of Santa Paula, by Union Oil Company of California.

The well, Hill 2, is producing from three intervals between 10,659 and 12,100 ft with tubing pressure of 325 psi and casing pressure of 1350 psi.

The bottom interval is a completely new producing zone for the field and the well extends the producing limits of the pool in a westerly direction.

Occidental to Confirm Rosecrans Discovery

Occidental Petroleum Corporation has arranged with Gene Reid Drilling, Inc., of Bakersfield, to drill two wells on its leases offsetting the G. R. Nance new fault block discovery wells in the Rosecrans area of Los Angeles County.

The arrangements were made following the recent successful completion of Nance's second well, Sjelin No. 6, located in Sec. 20, 3s, 13w. This well was completed and began flowing June 15, from a total depth of 7925 ft with 1042 ft of slotted liner ranging from 6873 to 7915 ft.

Reports from this well indicate a producing rate of from 350 to 400 bbl per day of 37 deg oil, with considerable gas flowing through a restricted choke.

The first Nance well, Busher No. 1, completed February 5, 1959, flowed at the rate of 240 bbl per day of 40 deg oil through a 14/16-in. choke, cutting 3% with 500,000 cu ft of gas.

Occidental Petroleum's leases are located between Rosecrans and Compton Boulevards west of McKinley Avenue and adjoin the Nance well locations on the east.

COLOMBIA

Additional Oil Found On Las Monas Structure

Cities Service Company announced a new oil well, with an indicated daily potential of 800 bbl of 35 deg oil, on the Las Monas structure of the two million-acre El Carare area in Colombia.

The well is producing from 99 ft of perforations at depths ranging from 4700 to 6375 ft. This is the third producing well drilled on the Las Monas structure by a subsidiary, Colombia-Cities Service Petroleum Corporation. An active drilling program is being carried forward to determine the extent of the field.

The Colombia project is a joint venture which includes Colombia-Cities Service as operator, Richfield Oil Corporation and Empresa Colombiana de Petroleos.

Another plus value:

INHERENT LUBRICATING QUALITIES BROADEN USE OF SEECO-MUL AS E-P ADDITIVE

On your next well, try Seeco-Mul Drilling Mud Emulsifier as an extreme pressure additive. Many operators have recently discovered this extra advantage in Seeco-Mul; in fact we can show you data on a number of field wells drilled under almost identical conditions that will convince you that Seeco-Mul is the most effective E-P agent you can use.

The efficiency of Seeco-Mul as an E-P agent is due to its chemical structure—the ability of one end of the Seeco-Mul molecule to adhere tightly to a metal surface, attracting another molecule to form the familiar micelle, or the joining of two molecules at opposite ends. This layer attracts other Seeco-Mul molecules, which build up to an extremely tough lubricating film that is difficult to remove and will withstand high pressure, successfully reducing metal-to-metal contact and subsequent wear, or galling, of the bearing surfaces.[1]

In addition to the E-P qualities, you get many other advantages with Seeco-Mul. Inasmuch as Seeco-Mul is a chemical emulsifier with superior wetting abilities, it is often run in so-called "soap" drilling fluids (the addition of detergents to fresh water muds, oil-and-water, and water-clay systems) to lower the surface tension, thereby wetting the formation ahead of the bit and keeping the bit clean. Such systems also afford a faster penetration rate and aid the suspended solids to drop out in the pits.

Too, with good lubricating qualities in the mud, less drill stem torque is required, pump pressures can be lowered and more evenly sustained, and a higher velocity of the fluid on bottom can be obtained . . . all of which means longer service life for liners, collars, tool joints, drill pipe, and the bits themselves.

Add to this the longer bit runs and the consequent savings in bits and rig time and you will agree that adding Seeco-Mul to the system is an investment rather than a drilling expense.

Let us show you how you can use Seeco-Mul profitably. We'll gladly send you illustrated literature and a lab sample of Seeco-Mul, or contact your local mud dealer. You can get full particulars without obligation.

[1] *McCutcheon, John W., "Synthetic Detergents."*

Make a good mud better...use

CROSSETT **Seeco-Mul** **DRILLING MUD EMULSIFIER**

Manufactured by the Chemical Division of The Crossett Company, Crossett, Arkansas

Seeco-Mul is the dried flake form of a compound of the sodium salts of abietic, linoleic, and oleic acids, together with quantities of wood tannins and lignins.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

What's doing in DRILLING

Assam Oil Continues Remarkable Drilling Rates

The Assam Oil Company is continuing its efforts to speed up the completion of wells in the Nahorkatiya area and marked improvement in drilling speeds has been achieved. The latest well at Nahorkatiya, No. 42, reached its final objective of 9659 ft in 10 days and 23 hr. This is the best performance so far recorded in India, beating by more than three days the previous record which was held by Well No. 41 where the total depth of 9589 ft was reached in 14 days and 8 hr.

Compared with a well of similar depth (No. 27) which was drilled in the same area in 1957, No. 42 showed an improvement of 45 percent in the overall drilling rate. Another improvement has been in the footage drilled with 8½-in. bits. Only six of these bits were used at No. 42, compared with seven at No. 41, 10 at No. 27, and eight at No. 38 to a similar depth.

Suggests Wage Information In Contractors' Bids

AAODC President Joe Zeppa has suggested to an oil company executive that drilling contractors be required to include schedules of wages and fringe benefits paid their personnel in their bids. The suggestion was prompted by the executive's expressed surprise at "the deterioration he found in the quality of drilling crews" during a recent tour of the drilling operations under his supervision. In the AAODC's official magazine, *The Drilling Contractor*, Zeppa said that he suggested that the wage information be weighed carefully "in evaluating the prices offered by each contractor before awarding the contract." He further stated that this "deterioration" in drilling crews is "the visible result of the ruinous prices which have been inflicted on the drilling business."

New Firm Specializes In Slim Hole Drilling

H. L. Rowley, drilling contractor and producer, has announced the formation of a new drilling company specializing in slim hole drilling operations. Named the Rowley Drilling Company, the firm is operating three slim hole rigs in the Gulf Coast area. The company will maintain offices in Natchez, Mississippi, and New Orleans. Rowley, president of the firm, listed other officers as Stephen J. Rowley, executive vice president; Philip G. Reynolds, vice president and superintendent of drilling; and Carl B. Kendrick, secretary and treasurer.

Union Oil Ready to Spud Argentine Test

With the arrival of a shipload of drilling equipment at Puerto Deseado, Argentina, Union Oil Company of California was ready to spud its first wildcat in the Latin American republic. Union Oil has a 27-year contract for exclusive exploration and development of two parcels totaling 4,000,000 acres in the provinces of Chabut and Santa Cruz, Argentina.

Due to the isolated area, the entire rig and portable camp were assembled at Houston, all items checked, and then disassembled for loading aboard ship. The drawworks was built in California, the derrick in Oklahoma, engines at Detroit, pumps at Chicago, camp trailers at Denver, drill pipe at Pittsburgh, and hundreds of items throughout the United States.

Because of the drill site's proximity to the Antarctic circle, Santa Fe Drilling Company, Whittier, California, which holds the drilling contract, fully winterized the rigs for year-round operation.

New Well Servicing Company Announced

The formation of Macworth Oil Well Servicing and Drilling Company has been announced by E. J. McBride and R. G. Worthy, owners. The new firm, with headquarters in Tyler, Texas, will specialize in well servicing, workover, rods, tubing, swabbing, and well completion. For the time being, Macworth will concentrate its operation in the East Texas and Western Louisiana areas.

McBride has been active in the drilling industry for the past 31 years. For the past 10 years, he has been associated with Delta Drilling Company as a toolpusher. Prior to that time he was with other drilling contractors in Dallas and Wichita Falls in a similar capacity. Worthy, a former Baylor University football star, is a well-known rancher and businessman in East and Central Texas.

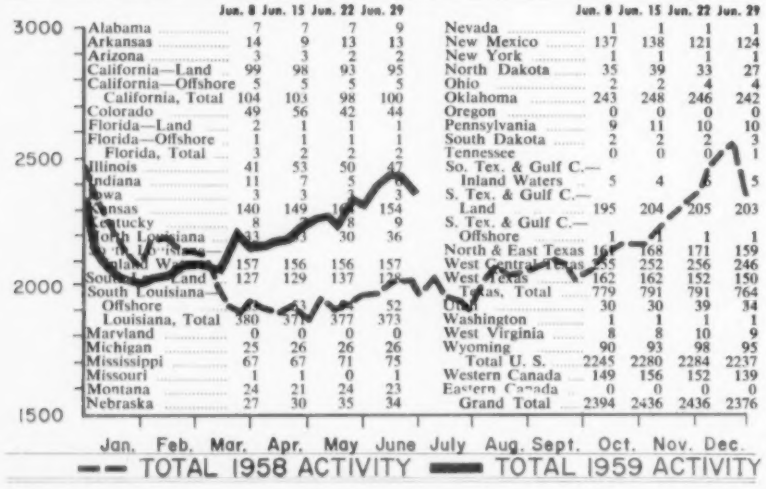
An-Son Offshore Buys Drilling Barge

Phillips Petroleum Company has sold its drilling barge, "J. P. Stephens," to An-Son Offshore Drilling Company, subsidiary of An-Son Drilling Company, of Oklahoma City. An-Son will move the rig to Block 18, Eugene Island area off Louisiana, where it will begin work on contracts for Shell Oil Company. The barge was commissioned at Orange, Texas, in 1954. It has a depth capacity of 18,000 ft and can operate in water up to 18 ft in depth.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

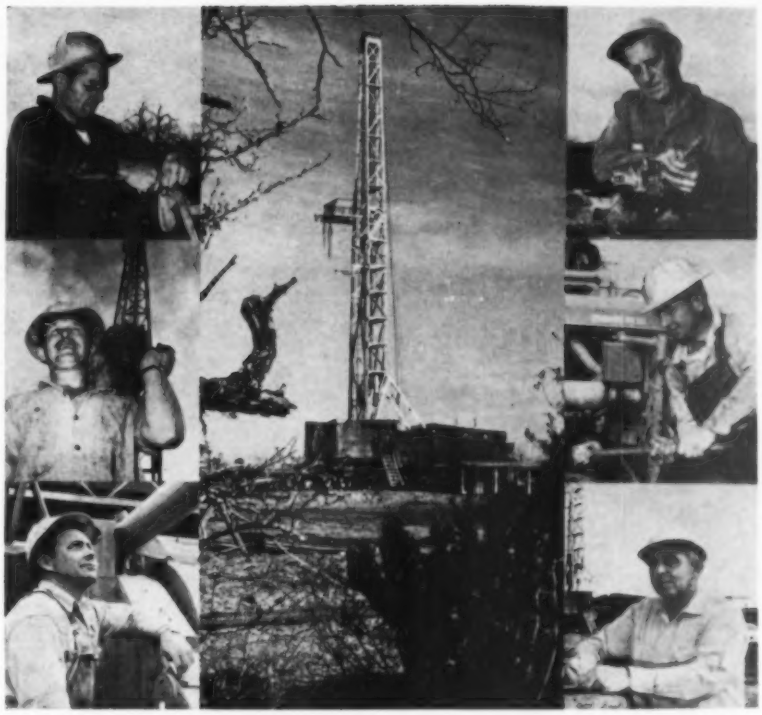
	Jun. 8	Jun. 15	Jun. 22	Jun. 29
Alabama	7	7	7	9
Arkansas	14	9	13	13
Arizona	3	3	2	2
California—Land	99	98	93	95
California—Offshore	5	5	5	5
California, Total	104	103	98	100
Colorado	49	56	42	44
Florida—Land	2	1	1	1
Florida—Offshore	1	1	1	1
Florida, Total	3	2	2	2
Illinois	41	53	50	47
Indiana	11	7	5	3
Iowa	3	3	3	3
Kansas	140	149	149	154
Kentucky	8	7	8	9
North Louisiana	33	33	30	36
Gulf Coast	124	123	126	116
Louisiana, W.	157	156	156	157
South Louisiana—Land	127	129	137	128
South Louisiana—Offshore	96	93	84	52
Louisiana, Total	380	378	377	373
Maryland	0	0	0	0
Michigan	25	26	26	26
Mississippi	67	67	71	75
Missouri	1	1	0	1
Montana	24	21	24	23
Nebraska	27	30	35	34
Nevada	1	1	1	1
New Mexico	137	138	121	124
New York	1	1	1	1
North Dakota	35	39	33	27
Ohio	2	2	4	4
Oklahoma	243	248	246	242
Oregon	0	0	0	0
Pennsylvania	9	11	10	10
South Dakota	2	2	2	3
Tennessee	0	0	0	1
So. Tex. & Gulf C.—Inland Waters	5	4	6	5
S. Tex. & Gulf C.—Land	195	204	205	203
S. Tex. & Gulf C.—Offshore	1	1	1	1
North & East Texas	161	168	171	159
West Central Texas	255	252	256	246
West Texas	162	162	152	150
Texas, Total	779	791	791	764
Utah	30	30	39	34
Washington	1	1	1	1
West Virginia	8	8	10	9
Wyoming	90	93	98	95
Total U. S.	2245	2280	2284	2237
Western Canada	149	156	152	139
Eastern Canada	0	0	0	0
Grand Total	2394	2436	2436	2376



Search Begun for "Mohole" Site

Preliminary seismographic work has begun in the search for a site for drilling the world's deepest man-made hole in a project aimed at answering age-old questions about the earth's interior. (See article entitled "Operation Mohole" on page B-24.) Three ships have joined in the three-week survey, called 'Expedition Fanfare," which is part of tentative planning for drilling the "Mohole," a name given to the National Academy of Sciences' project for getting a piece of the earth's mantle.

Somewhere — perhaps off Guadalupe Island, about 300 miles to the south of La Jolla, California — the scientists hope to find a spot for drilling from sea level 30,000 ft into the earth.



Mobile Rig Is Mobile Home . . . for 17 men on Shell Oil Company's Rig 25, now drilling in the Lower Rio Grande Valley. All but one of its crew have been with the rig since it drilled its first hole in early 1954. Since then, the rig has drilled 170 wells in 16 different Texas oil fields for an average of 34 wells per year, cutting a total of more than 750,000 ft of hole.

Though officially designed to drill to a maximum depth of 7500 ft, the rig has been adequate for much deeper holes. It is now being used to drill a 10,000-ft test.

The rig is pictured on location in the North Rincon field of Starr County. Around it are six members of its crew, shown at their everyday jobs. The men are: (left, top to bottom) R. R. Krietsch, derrickman; H. L. Sens, Jr., rotary helper; M. M. Clark, driller; (right, top to bottom) L. L. Dunham, mechanic; R. B. McMillan, rotary helper; and E. Fose, drilling foreman.

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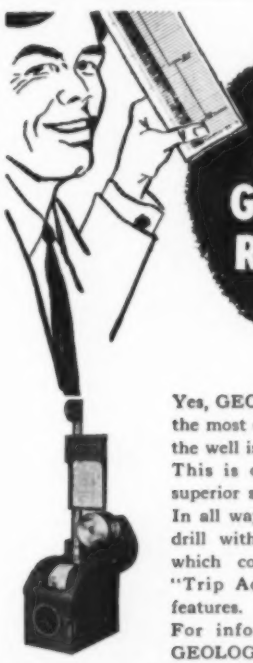

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BROWN OIL TOOLS

Continually launching new developments for tomorrow's production

Brown CAM-LOK Packer, New Development — most economical and versatile packer available. Use as a tension or weight-set packer, tubing anchor or tubing catcher.

Brown HS-8-5 Hydraulic-Set Retrievable Packer, New Development — to be used as uppermost packer when producing five zones through independent tubing strings.

Brown HS-16-1 Hydraulic-Set Retrievable Packer, New Development—latest hydraulic-set packer for use in single zone completions or as bottom packer in multiple completions. Handles extremely high differential pressures.

Complete information on these new developments, the CAM-LOK HS-8-5 and HS-16-1 packers, is available at all Brown Oil Tool locations. Day in and day out, Brown packers operate safely, efficiently to provide maximum economy for the operator.

BROWN
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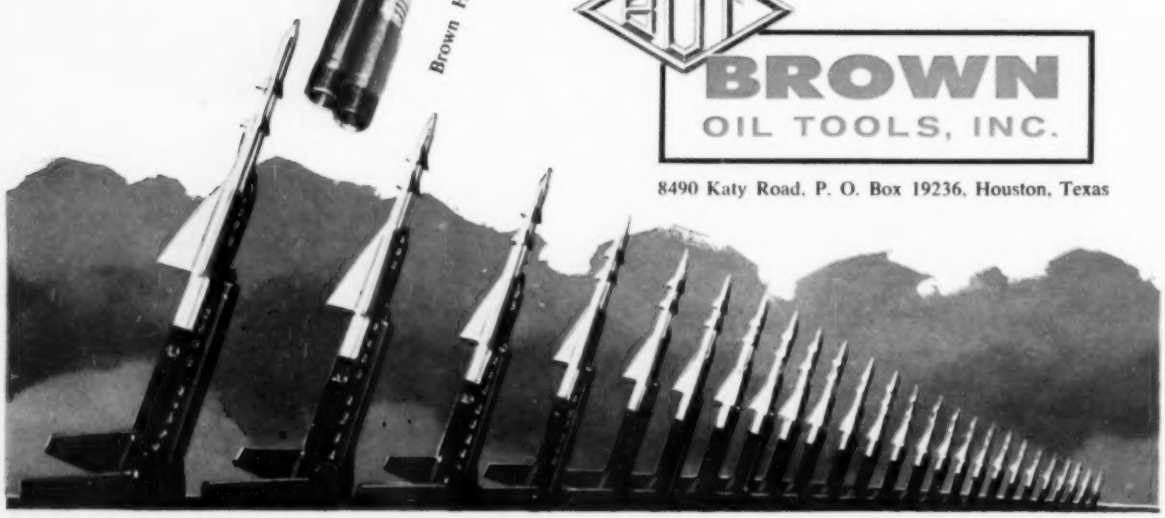


Ask your Brown representative about the full line of production equipment, liner equipment, specialty and fishing tools.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New Drilling and Producing EQUIPMENT

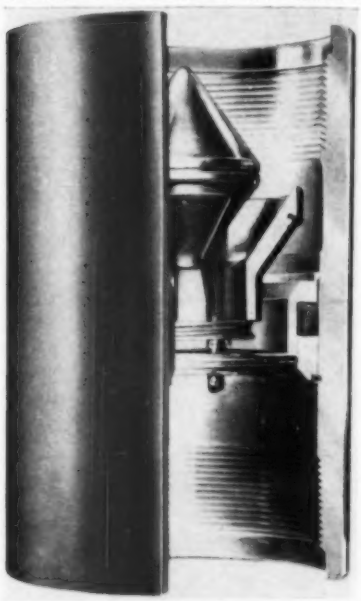
Automatic Device Changes Circular Recording Charts

Maeder-Squier Company announces a new patented device for automatically changing circular recording charts. The method affords the use of as many as 40 circular charts in a single recorder, disengages the charts one by one at virtually any desired time/date frequency, and drops them by gravity into a self-contained storage box. Unit uses only a small portion of available clock power. Any number of field or plant recorders can be serviced without manual attention, at the identical moment, thus making it possible to correlate the charts with master meter charts without multiple computations. *Maeder-Squier Company.*

Circle number (1) on reply card.

Low Resistance Check Valve

Reda Pump Company has announced a new low resistance check valve which is named the Reda Model "AA". Normal construction is "Ni-Resist" and stainless



steel parts in steel housing; valve seat is rubber cushioned. Less restriction to flow results from the use of 2 poppets instead of the conventional 1 poppet type check valve. Operation is that of a valve in a valve. With movement of fluid, poppets begin to open dividing the fluid between the 2 poppets. As flow increases, openings also increase to maintain the least resistance to flow. *Reda Pump Company.*

Circle number (2) on reply card.

Mud-Weighing Device Records Continuous Sample

A new mud-weighing device automatically indicates and records the weight of mud being discharged. Unit channels off a flow of mud directly from the flow line. Pumping the mud through a specially-designed scale, it weighs a continuous flow sample. Weight is permanently recorded on a clock-driven chart and indicated continuously on a manometer. Mud sample then flows to the shale shaker.

Any number of recording and/or indicating elements can be operated from a single sensing source and can be mounted anywhere on the rig. Accuracy is enhanced because the mud is weighed before it can trap air or lose gas and cuttings. *Bell Mudwate Corporation.*

Circle number (3) on reply card.

Multi-Port Rotary Selector Valves

Three new models of multi-port rotary selector valves have been announced by Win-Well. Model 424-15C is rated for 1500 psi working pressure and has built-in flanges. Model 424-6C is designed for use on 4-well installations. Model 736-6C has seven 3-in. inlet ports and a common 6-in. outlet. It is primarily designed for high volume flow or paraffin conditions.

Discharge lines in the valves have been lowered and placed on a 45-deg angle. Entire lower portion of the valve slopes into the discharge line, preventing build-up of materials in the body. All 3 models of the selector valves are designed for easy conversion to automatic operation. *Win-Well Manufacturing Company.*

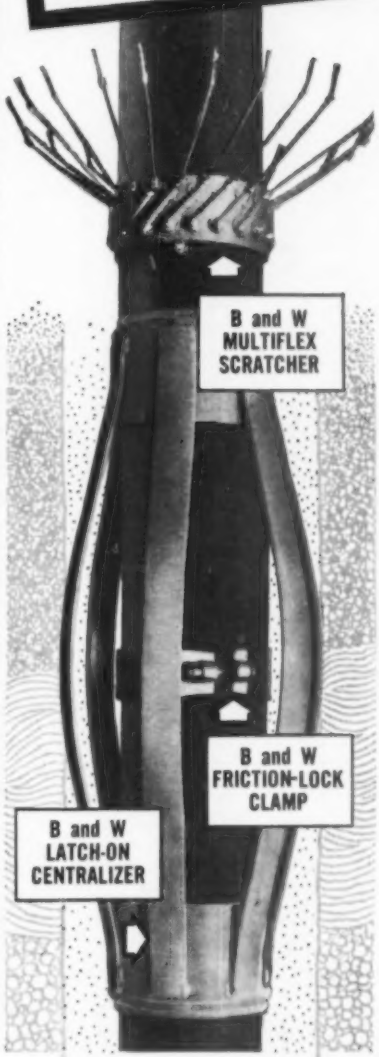
Circle number (4) on reply card.

Electronic Measuring Device Highly Accurate

A new electronic measuring device, accurate within a ½-in. over 5 miles of unobstructed terrain, has been introduced by Sweden's Svenska AB through Surveyors Service Company. Called the Geodimeter, the unit projects a highly collimated light beam to a distant reflector. Light is reflected back to the Geodimeter by unique and multi-prism reflectors to determine the distance that the light waves have traveled. Designed for surveyors, engineers, and mapping parties, the unit is only 12-in. square and weighs 35 lb. It is calibrated for measuring distances of up to 3 miles. *Surveyors Service Co.*

Circle number (5) on reply card.

B and W
A Good Combination for a GOOD CEMENT JOB



OTHER PRIMARY CEMENTING TOOLS: Hinged Nu-Coil Scratchers • Rotating Scratchers, Multi-Flex and Nu-Coil Types • Automatic Stop Collars • Stabilizers • Rotator Collars • Liner Centralizers.

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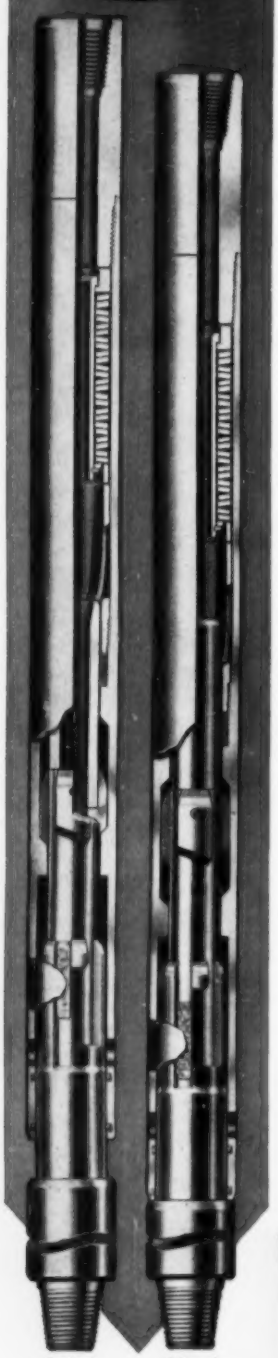
122

For running in the drill string . . .

Positive JAR-DOWN ACTION

. . . plus Safety Joint protection!



See the Shaffer section of your Composite Catalog.

THE SHAFFER-WAGGENER BUMPER SAFETY JOINT

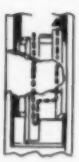
There is no other tool like the Shaffer-Waggener Bumper Safety Joint. It combines—in ONE tool—a choice of *jar-down* and *releasing* actions, both under complete control of the operator. What's more, the tool is so rugged it is run as part of the drill string to protect against stuck pipe.

In actual well service it has operated easily at depths below 18,000 feet, and has given no operating problems even in directionally-drilled wells with extreme slant.

Jar-Down Action

▶ **RUN IT IN THE DRILL STRING**—It is specifically designed to withstand the continuous vibration and heavy torque loads of today's drilling operations.

▶ **TO JAR DOWN** whenever the drill pipe threatens to stick—or to drive drill collars out of keyseats and to free "balled-up" bits—simply slack off weight equivalent to about 2,000 feet of drill pipe onto the tool. This releases the tripping mechanism, automatically striking a sharp *down* blow. Raising the string automatically re-sets the tool for another blow—and blows can be struck repeatedly as fast as the string can be raised and lowered. And no torque or twisting strains are placed in string!



Releasing Action

▶ **TO RELEASE,** in the event jarring will not loosen the stuck string, simply trip the tool and apply reverse torque as the string is slowly raised. Only one-sixth turn of the tool rotates the drive keys into unlocking slots so that complete release is effected by continuing to raise the string.

ANOTHER ADVANTAGE—the tool transmits full torque loads in *either* direction through three rugged drive keys—not through easily-damaged threads. It is the strongest joint in the string—not the weakest, as with conventional safety joints.

Also, the tool can be re-connected again by simply lowering the top portion over the lower portion and reversing the releasing action. It is ideal for use in fishing strings!

Free 8 page bulletin gives the full story on the Shaffer-Waggener Bumper Safety Joint. Write for it—or ask your nearest Shaffer representative.

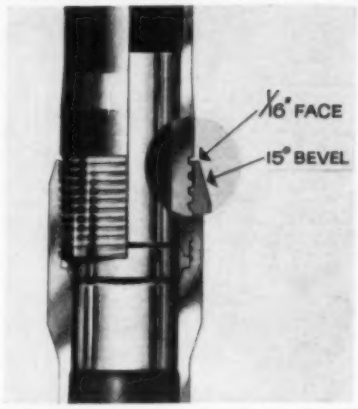
SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT - FISHING TOOLS THAT EXCEL

36 YEARS OF OIL TOOL LEADERSHIP

Tubing Box-End Has No-Hang Bevel

To facilitate running tubing in multiple-completion wells, the box end of Jones & Laughlin's Grayloc tubing is being manufactured with a 1/16-in. bearing face and a 15-deg bevel. This design change eliminates hang-up of tubing strings going into or coming out of a well. With the bevelled box end, Grayloc



tubing and an adjacent string of API threaded and coupled tubing can slide past each other freely.

The tubing, designed for use in high pressure wells because of its leak-resistant joints, is available in 2⅜, 2⅞, and 3½-in. OD sizes, and in grades J-55, N-80, and P-105. *Jones & Laughlin Steel Corp.*

Circle number (6) on reply card.

Electronic Unit Transmits Printed or Drawn Material

Paper work, records, documents, orders, etc. can be sent by a new electronic facsimile unit over either leased wires or by microwave as easily as making a telephone call. With the Electronic Messenger manufactured by Electric Communications, Inc., any material — whether

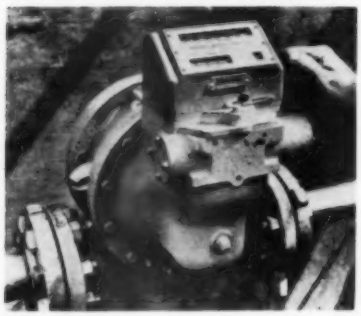
printed, typed, written, or drawn — can be transmitted and reproduced to other stations in the system. An electric eye scans the material and sends electrical impulses over telephone lines, direct wire, or microwave to duplicate the original message on one or more companion machines anywhere — in the same building or hundreds of miles away. When not sending, the machine is ready at all times to receive communications. *Electronic Communications, Inc., Facsimile Equipment Division.*

Circle number (7) on reply card.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New In-Line LACT Meter

A new Rotocycle meter, manufactured by Rockwell, provides economy and adaptability on horizontal piping lines by the use of a special case design that eliminates elbows or manifolds. Designed for



LACT systems, meter is available with small reset, large reset, non-reset, or printing register, and accurately measures flow of rates ranging from 20 to 100 gal per min. Standard accessories available are strainers, register extensions, swivel adapters, impulse contactors, and temperature compensator. Meter can also be supplied with a transmitter for remote registration and a quantity control valve and register for pre-determined shock-free closing. *Rockwell Manufacturing Co.*

Circle number (8) on reply card.

Couplings and Fittings For Grooved-End Pipe

A new line of couplings and fittings for joining grooved-end pipe has been announced by Dresser Manufacturing Division. Designated the Dresser Style 98, "Kupl-Lok," the line includes couplings, ells, tees, reducers, and line caps. Available in 2 complete series — the 98-1 for working pressures up to 500 psi, and the 98-2 for working pressures to 1000 psi — the bodies are of rugged malleable iron and are shopcoated. Bolts are of carbon steel with an oil finish. Fittings are assembled by drawing up the 2 bolts which extend through the halves. Gaskets firmly grip the pipe ends, maintaining even pressure around the circumference of the pipe. *Dresser Manufacturing Div., one of the Dresser Industries.*

Circle number (9) on reply card.

Hydraulic-Set Packer for Single, Multiple Completion

Brown Oil Tools has announced development of the Brown HS-16-1 hydraulic-set packer for single completions, dual completions with 1 zone through the annulus, or as the bottom packer for dual, triple, quadruple, or quintuple parallel-string completions. The packer permits positive control of the well at all times because the well head is put into place before the drilling fluid is displaced or the packer is set. Complete circulation and cleaning of producing zones can be accomplished before the packer is set.

Tubing is landed in normal tension, due to its own weight. No tubing movement occurs in the setting procedure. Packer may be released by right-hand rotation of the tubing. It is equipped with 2 seal assemblies to assure a positive seal and has 2 slip sets, facing in opposite directions, to withstand high differential pressure from either side. *Brown Oil Tools, Inc.*

Circle number (10) on reply card.

For fishing, testing and core-drilling strings . . .

. . . plus Safety Joint protection!

Positive JAR-UP ACTION

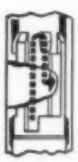
THE SHAFFER OIL-SEALED JAR SAFETY JOINT

The Shaffer Oil-Sealed Jar Safety Joint is the only tool that combines a choice of *jar-up* and *releasing* actions, both under complete control of the operator at all times. What's more, all operating parts are sealed in a chamber filled with clean oil, fully protected against mud, sand and corrosive fluids.

The sealed-in-oil protection not only safeguards against abrasion and corrosion, and minimizes pressure differentials on packing elements, but also insures constant operating characteristics at all depths. This makes the tool ideal for fishing, testing and similar strings where light connections and equipment are used!

Jar-Up Action

JARRING ACTION IS AUTOMATIC—simply raise the drill string until tension equals the pre-set tripping load, whereupon a sharp up blow is struck. Lowering the tool automatically re-sets the tripping mechanism for another blow—and repeated blows can be struck as fast as the string can be raised and lowered.



Releasing Action

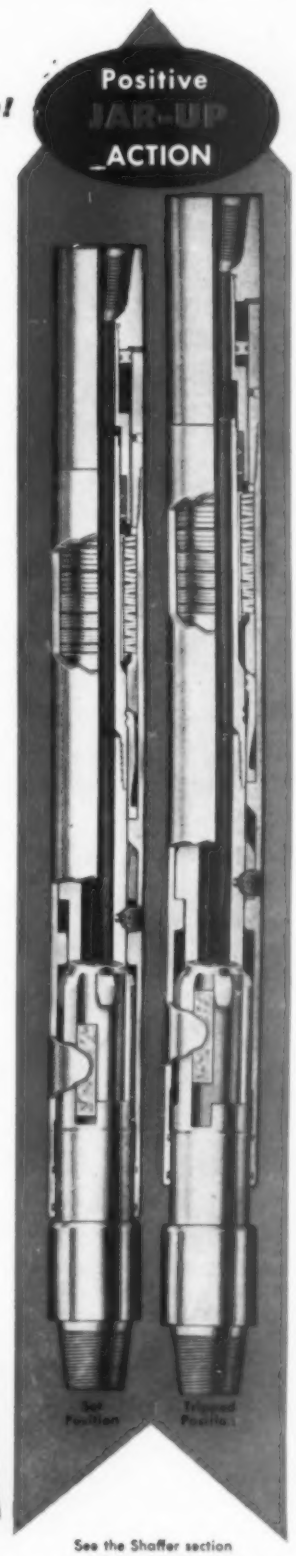
ONLY STRAIGHT PULL is necessary to operate the tool—no torque or other secondary operations to affect the light connections commonly used in fishing, testing and coring strings.

TO RELEASE, in the event the fish or stuck string cannot be loosened, simply trip the tool and apply reverse torque as the string is slowly lowered. Only one-sixth turn of the drive keys rotates them into an unlocking slot whereupon raising the string allows the parts to unlock.

AND NOTE THIS—not only does the tool transmit full torque loads in *either* direction, but no threads are used in the releasing mechanism. Therefore there's no risk of torque over-tightening the tool—nor can reverse rotation accidentally release it.

Also, force of the blow is absorbed by integral knocker heads—not by easily damaged drive keys or threads. The tool is designed for *sustained* jarring operations. And since it does not depend upon friction for its tripping action, the Jar Safety Joint always operates with the same pre-set action. Light strings are not subjected to unpredictable loads!

Free 8 page booklet gives many other facts about the Shaffer Oil-Sealed Jar Safety Joint. Write for it—or ask your nearest Shaffer representative.



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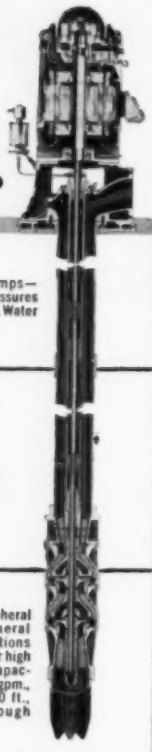
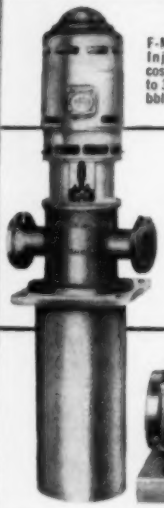
FOR WATER FLOODING
you're money ahead with
F-M PUMPING...

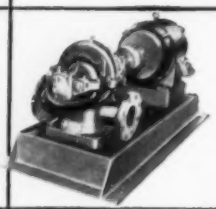


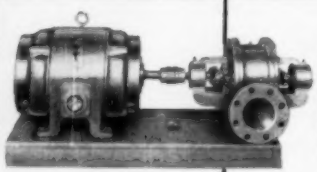


F-M Inverted Pot-Type Turbine Injection Pumps—for lowest cost water flooding at pressures to 3000 psi., capacities to 50,000 bbl. per day.

F-M Turbine-Type Well Pumps—capacities to 30,000 gpm., pressures to 1500 ft. Sizes 4" through 48". Water or oil lubricated.

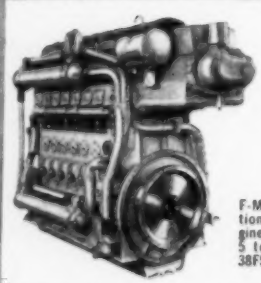
F-M Double-Suction Single-Stage Centrifugal Pumps—for economical back washing and filtering operations at capacities and heads required.



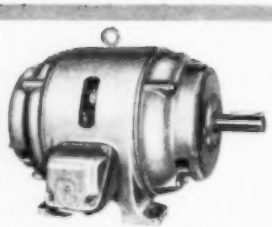


F-M Westco Peripheral Pumps—for general purpose applications on low, medium or high head service. Capacities 10 to 200 gpm., pressures to 900 ft., sizes 1¼" through 2½".

matched by **F-M POWER!**



F-M Diesel, Spark Ignition and Dual Fuel engines for pump drivers, 5 to 3000 hp. Model 38F5¼ O-P shown.



F-M Electric Motors—designed for oilfield service. Ratings from ½ to 2500 hp. 600 to 3600 rpm. Guarded Dripproof Motor shown.

You cut costs and eliminate problems all the way when you specify Fairbanks-Morse for *both* power and pumping!

1 *One* source of supply speeds deliveries of every unit—lets you maintain schedules and meet emergencies!

2 *One* source of responsibility assures fast, positive service and repairs—keeps you in operation!

3 *One* source of engineering and manufacturing means matched performance of pump and driver—expert field-proven set-ups you can depend on for dependable output and economy!

Get the facts on the broad F-M Oilfield line—write Fairbanks, Morse & Co., Oilfield Division, 1713 N. Market St., Dallas 2, Texas.

FAIRBANKS-MORSE
a name worth remembering when you want the BEST

DIESEL, DUAL FUEL AND GAS ENGINES • LOCOMOTIVES • ELECTRIC MOTORS • PUMPS • COMPRESSORS • GENERATORS • SCALES • MAGNETOS • HOME WATER SYSTEMS

B-122

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New Equipment

Portable Crude Oil Treater Is Tested

A new crude oil treater has been developed by H. E. Gill. The treater, mounted on wheels, measures 11 ft 8½ in. long, 69 in. high, 40 in. wide at the top, and 32 in. wide across the bottom at the firebox. A simple crank mechanism permits cleaning the treater in 15 to 20 seconds. When the crank is turned, a valve on the drain line is opened and cleaning rakes in the bottom of the treater push sediments into drain-off openings.

Model is mounted on wheels which are easily removed for mounting on skids or on a permanent foundation. Oil outlet valve and water outlet valve are controlled by an automatic fluid level control. Treater is built to operate on pressures up to 30 psi, but can be built to operate on much higher pressures. *H. E. Gill.*

Circle number (11) on reply card.

Electric Log File Cabinet

Ross-Martin announces a new 5-drawer cabinet to hold electric well logs. By means of 2 separate follow blocks in each drawer, the cabinet will accommodate 500 average electric logs. Drawers slide all the way out for complete accessibility and the cabinet occupies only 3½ sq ft of floor space. Custom designed filing supplies, folders, file envelopes and guides for the file are available. *Ross-Martin Company.*

Circle number (12) on reply card.

Vertical Free Water Knockout

A vertical metering free water knockout is being marketed by Odex Engineering. By eliminating the water leg and substituting an interface control, the manufacturer claims to have increased metering efficiency. The interface control is combined with a throttling 3-way, 3-position water valve to maintain a constant interface level, even under conditions of varying gravities. The separators can be used independently on a single lease or may be integrated into a complete remote-controlled field-automation system. *Odex Engineering Company.*

Circle number (13) on reply card.

Remote Starting Electric Plant

Kohler Company introduces a new large capacity emergency electric plant, Model 100R81, which is a 100-kw, 120/208-v a-c plant equipped for remote starting. It is electrically cranked with an automotive type 12-v starting battery. Voltage regulation is within ± 2 percent, frequency regulation, 3 cycles. A 6-cylinder engine develops 200 hp at 1800 rpm and is of heavy-duty design. It is also available with diesel engine in 1200 or 1800 rpm. *Kohler Company.*

Circle number (14) on reply card.

New Literature

World-Wide Equipment And Services Guide

The 1959 edition of Dresser Industries' "World-Wide Guide to Dresser Equipment and Technical Services" has been published. The 68-page book is illustrated and provides reference to the products and services supplied by the group of companies throughout the world. Convenient lists of representatives and their addresses in various countries are included. *Dresser Industries, Inc.*

Circle number (15) on reply card.

Waterflooding Services

Bethlehem waterflooding services are completely described in a new booklet which includes discussions of raw-water supply, water treatment, treated-water pumps, and field distribution systems. Also included are illustrated examples of typical waterflooding injection plants, basic design drawings for estimating costs of construction, and overall working drawings of typical projects. *Bethlehem Steel Company, Supply Division.*

Circle number (16) on reply card.

Hydraulic Pumping for Dual Completion Wells

An illustrated brochure describing the new Axelson Duo-Hydrax hydraulic pumping unit for the production of dual completed wells is available. Brochure includes product description, production capabilities, hydraulic circuitry, and advantages incorporated into the unit design. Unit is available in 4, 6, and 10-ft stroke lengths. *Axelson Division, U. S. Industries, Inc.*

Circle number (17) on reply card.

New Slush Pumps

Bulletins covering 3 new power slush pumps are available from National Supply. Pumps are the K-500 rated at 513 input hp, the K-700 with 700 input hp rating, and the H-1250 with 1250 input hp rating. Among the features of the pumps described in the bulletins are fast-change cylinder heads and valve pot cover plates. *The National Supply Company.*

Circle number (18) on reply card.

Catalog Outlines Rubber Products

Oil States Rubber has prepared a general catalog presenting its complete line of rubber components for the oil industry. Catalog includes complete descriptions and specifications of tubing and casing swabs, line and pipe wipers, tubing packer cups, sucker rod and tubing guides, and rubber bonding service for tubing used in multiple completion wells. *Oil States Rubber Company.*

Circle number (19) on reply card.

Handbook Outlines Cable Fishing Tools, Methods

A 12-page field catalog-handbook covering fishing cable guide and side-door fishing methods is available from Bowen Itco. Brochure discusses methods and equipment used in fishing for wireline tools in either a cased or open hole. It gives complete and graphically illustrated operating and maintenance instructions. Price list is also included. *Bowen Itco, Inc.*

Circle number (20) on reply card.

USE HERCULES

equipment to produce MORE oil at LESS cost

HERCULES TYPE SOS

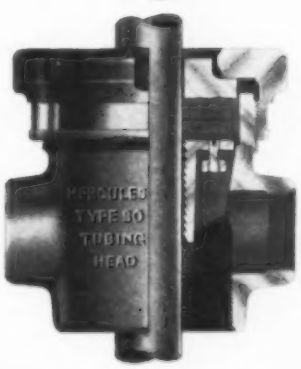
TUBING HEAD

Hercules "Type SOS" is a 4000 pound test stripper tubing head. The lower section contains the neoprene tubing stripper; the upper section or bowl contains the slips and packing arrangement. The SOS is unsurpassed for use in well servicing operations in addition to its use in flowing wells.

HERCULES TYPE SO

TUBING HEAD

Hercules "Type SO" tubing head is actually the lower section of the "Type SOS" tubing head, containing the slips and packing arrangement. It is particularly suitable for pumping due to its compactness, being approximately 12 inches high.



HERCULES TOOL TULSA

HERCULES Products are sold through All Supply Stores

HERCULES TOOL COMPANY

Manufacturers of Oil Field Equipment

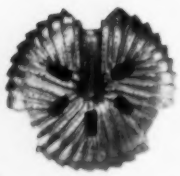
GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA

Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.

HYCALOG
V-DOOR
DIAMOND DRILL BITS
PATENT PENDING

HYCALOG

SAVES $40 PER FOOT IN DEEP VENEZUELAN WELL



DRILLING BELOW 16,500', a 5 13/16" Hycalog V-Door bit recently completed a run in a formation where conventional rock bits had averaged only about 60 feet. By maintaining the same rate of penetration and staying on bottom much longer, the V-Door effected overall savings of approximately $40.00 per foot including bit and rig costs.

In hard formations and shales, Hycalog V-Doors are racking up new records of drilling economy. So how about letting us prove it to you in your next well? *And include* Hycalog *well logging and drill function recording.*

Hycalog, Inc.
505 AERO DRIVE
SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS DIAMOND CORING
WELL LOGGING CORE ANALYSIS

New Literature

Double Barrel Insert Rod Pump

A bulletin from Pacific Pumps describes the improved Type "D" double barrel insert rod pump, which consists basically of two RW pumps in tandem: Upper pump is a traveling barrel pump and lower is a traveling plunger pump. A cutaway drawing and a specifications chart are included in this new bulletin, as well as charts comparing the pump with others of the same size. *Pacific Pumps, Inc., A Division of Dresser Industries, Inc.*

Circle number (21) on reply card.

Drivers' Manual From PESA

Months of research and compilation of data from all parts of the country are incorporated in a 51-page Drivers' Manual being distributed to member companies by the Petroleum Equipment Suppliers Association. The pocket-size publication is tabbed for easy reference and is profusely illustrated. Major divisions of the manual are: (1) Vehicle operation, (2) automobile and truck maintenance, (3) vehicle collision, and (4) accident reporting. *Petroleum Equipment Suppliers Association.*

Circle number (22) on reply card.

Machinery Brochures

A series of new brochures on all Mid-Continent machinery is being offered. Each brochure contains a complete description of the product including pictures and diagrams, specifications, dimensional layouts, and power flow diagrams. Subjects treated are traveling blocks, rotary tables, rig drives, drawworks. *Mid-Continent Supply Company.*

Circle number (23) on reply card.

Abrasive Jetting Service Described

Dowell has prepared a technical report on its Hydrojet abrasive jetting service, in which a fluid containing abrasive solids is pumped through small jets against the surface of pipe or formation to create perforations. Report includes a description of the service, the tools used, test data, and a case history. *Dowell Division of The Dow Chemical Company.*

Circle number (24) on reply card.

Derrick Lighting Bulletin

New bulletin on Joy string-a-lite portable lighting equipment for oil and gas derricks, masts, and associated areas has been published. Information on the entire line of lighting, with assemblies for all types of masts and rigs, is contained in the 8-page bulletin. Major components include derrick lights, floodlamps, distribution centers, connectors, extensions, and feeder lines. *Joy Manufacturing Company.*

Circle number (25) on reply card.

High-Speed Gear Drives

Western Gear Corporation has published a highly-illustrated, 20-page booklet covering the company's lines of high-speed gear drive units. Included are discussions covering selection and ratio factors, service factors, horsepower ratings, outline dimensions, assembly details, lubrication system, and ordering instructions. *Western Gear Corporation.*

Circle number (26) on reply card.

Diatomaceous Earth Products Bulletin

A new 4-page service bulletin giving complete technical data and properties of Aquafil's diatomaceous earth products is available. Diatomaceous earth, mined and processed in Nevada, is fully described, along with a complete outline of its many uses. *Aquafil Company.*

Circle number (27) on reply card.

Gas Lift for Marginal Wells

A new folder from Merla Tool describes several types of installations in which Types WF-3 and WFM-3 gas lift valves are being used to produce stripper wells. Method utilizes gas lift without surface controllers and without large volume gas lines, and is fully described in the folder. *Merla Tool Corporation.*

Circle number (28) on reply card.

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

INCREASE PRODUCTION

CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy cleanout with fewer round trips and less downtime, use world famous Miller Sand Pumps.

Write for descriptive price list.

SAND PUMP SIZES IN STOCK

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in. Lengths, 20, 25, 30 ft.

Composite Catalog Page 3400

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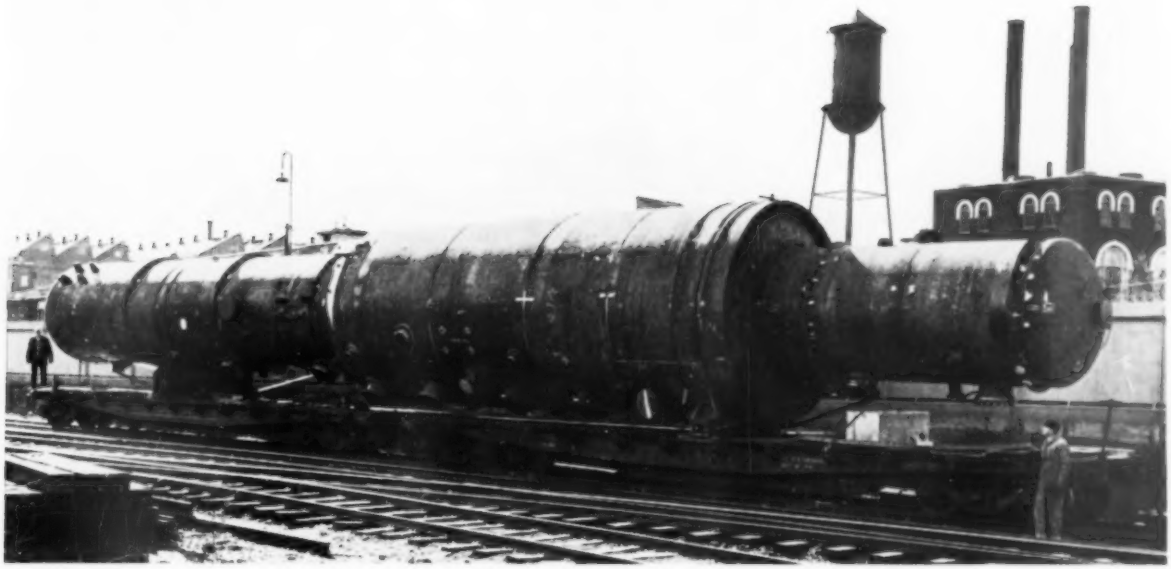
Miller Sand Pump Co.
General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK 20, N. Y.



VERSATILITY

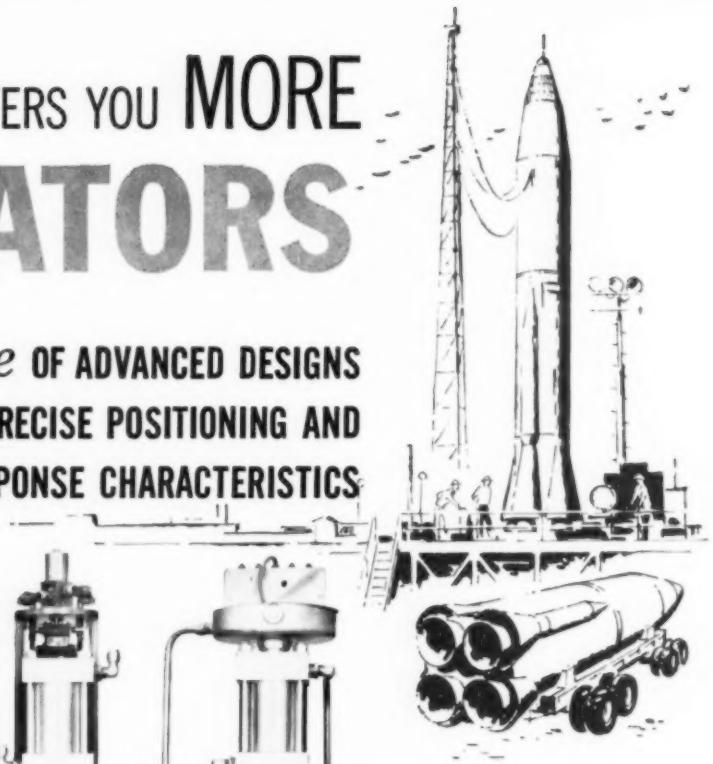
SOLVES PROBLEMS IN SHIPPING PROCEDURE

The variety of large-size work which Sun Ship's shops produce is matched by a variety of equally important shipping problems. Sun's facilities for shipping by water (overseas, coastal, or inland)—directly from our plant, are often the most economical available, and when large pressure vessels, such as those shown here, are scheduled for overseas shipment, direct, plant-to-ship loading saves additional time and expense.

Inland customers benefit from our ability to pre-check clearances and schedule shipments by rail or truck before production ever begins, so that delivery on schedule . . . on budget . . . is assured. Thus VERSATILITY . . . which has been made a "standard procedure" through Sun's experience . . . is extended through one more avenue . . . Shipping Procedure.

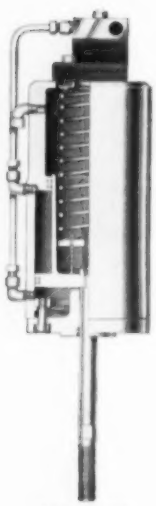
Annin OFFERS YOU MORE IN ACTUATORS

Your choice OF ADVANCED DESIGNS WITH MORE PRECISE POSITIONING AND DYNAMIC RESPONSE CHARACTERISTICS



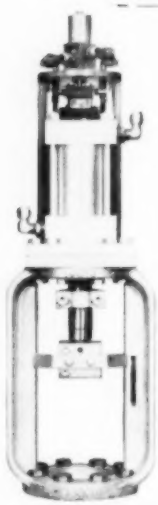
1542 & 1544 SERIES DOMOTOR POWERED ACTUATORS

Two types, "Direct Thrust" (illustrated) or "Lever" units are available for any application requiring accurate positioning in response to a pneumatic signal, such as butterfly valves, dampers, turbines and engine governors. Guaranteed positioning accuracy of better than 0.001" per inch of stroke over the complete range of piston travel is combined with a smooth operating action that provides an accurate, stable output force.



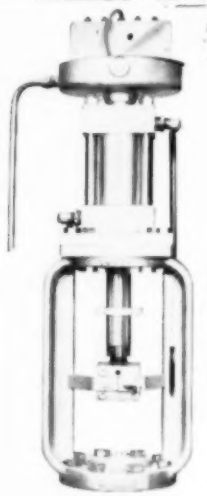
600 SERIES STROKE POSITIONING ACTUATORS

Offered primarily for the control of variable speed drives, rheostats, pumps and cams, as well as control valves, with strokes up to 6 inches and forces up to 2510 pounds of thrust. Compact and rugged, for easy mounting on existing equipment. May be operated from a standard 3-15 psi instrument signal, with a positional accuracy within 0.001" per inch of stroke.



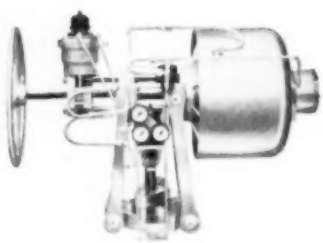
10,000 SERIES PNEUMATIC-HYDRAULIC ACTUATORS

For valves requiring strokes to 6 inches and thrusts to 100,000 lbs. Furnished on body assemblies where process conditions require very fine valve response, hi-speed and stability. Operate on 1500 psi oil supply system from any common instrument air signal.



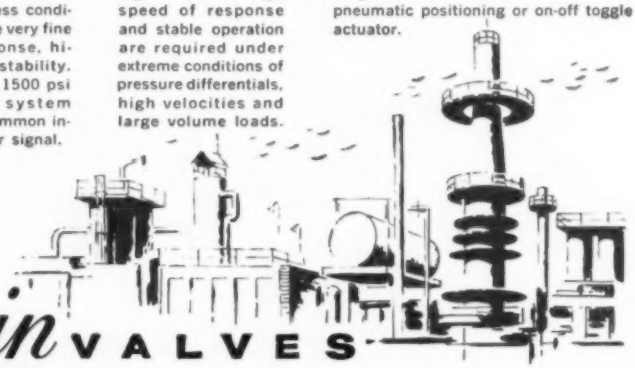
20,000 SERIES ELECTRO-HYDRAULIC ACTUATORS

Provide a means of converting an electrical signal to a powerful hydraulic positioning force, where high speed of response and stable operation are required under extreme conditions of pressure differentials, high velocities and large volume loads.



TOGGLE ACTUATORS

For process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Three types are offered: pneumatic positioning, pneumatic on-off, and manual control, all embodying the toggle actuator; or a manual control arrangement can be combined with the pneumatic positioning or on-off toggle actuator.



Annin VALVES

THE ANNIN COMPANY
1040 S. Vail Avenue, Montebello, California

Write for Bulletin 1236-ST

WITH THE EDITOR . . .

J. C. Webb, P. E.

A Look to the Future . . . FACT or FANTASY?

Where does one stop and the other begin? It probably depends on the perspective with which one views the future. For some, fantasy might start 5 or 10 years hence depending on their engrossment with the immediate future. For them it is pure fantasy to say that man may set foot on the Moon in 1965 . . . and upon Mars and Venus 3 years later. Dr. Herbert F. York, Chief Scientist for the Defense Department's Advanced Research Projects thinks that this is quite possible, if sufficient priority is assigned them. WHAT? . . . man traveling at speed approaching 670 MILLION MILES PER HOUR within the next 40 years. That is 189,000 miles per second . . . greater even than the speed of light? . . . Fantasy? . . . not to Dr. Eugen Sanger, Director of the Institute of Jet Propulsion Physics at the Technical University of Stuttgart, Germany.

These "Fantasies" were contained in a staff report by the Select Committee on Astronautics and Space Exploration released by the United States House of Representatives in April of this year. They predict the next 10 years in Space. To the layman they truly are fantastic. However, go back 100 years and stand alongside the early men in the petroleum industry. Who could predict this present giant of an industry . . . refining 2.8 BILLION barrels of oil a year? Some might have foreseen the displacement of the whale oil industry!

Let's look now to the year 2059 A.D. by projection. Excluding world catastrophe, population increases will bring greater demands on the world's petroleum sources. Our free economic law of supply and demand . . . with profit as a balance, will bring about the discovery of additional reserves through advances in technology. But petroleum exists in the world in a finite quantity and must eventually be exhausted. Long before that time petroleum's role will be changed from a primary energy source to that of a raw material for durable production. This leaves only nuclear energy as a dependable source of energy in important quantities. Refineries in the future will continue to grow in size . . . *to a point*, in automation, and in their dependence on nuclear energy as the source of process energy . . . both for work and for chemical reaction. Along with the refineries will grow the now "baby giant" . . . PETROCHEMICALS. By the year 2059 A.D. there will no longer be refineries . . . only giant petrochemical plants running with complete automation and coordination, and a minimum of human influence for operation and maintenance.

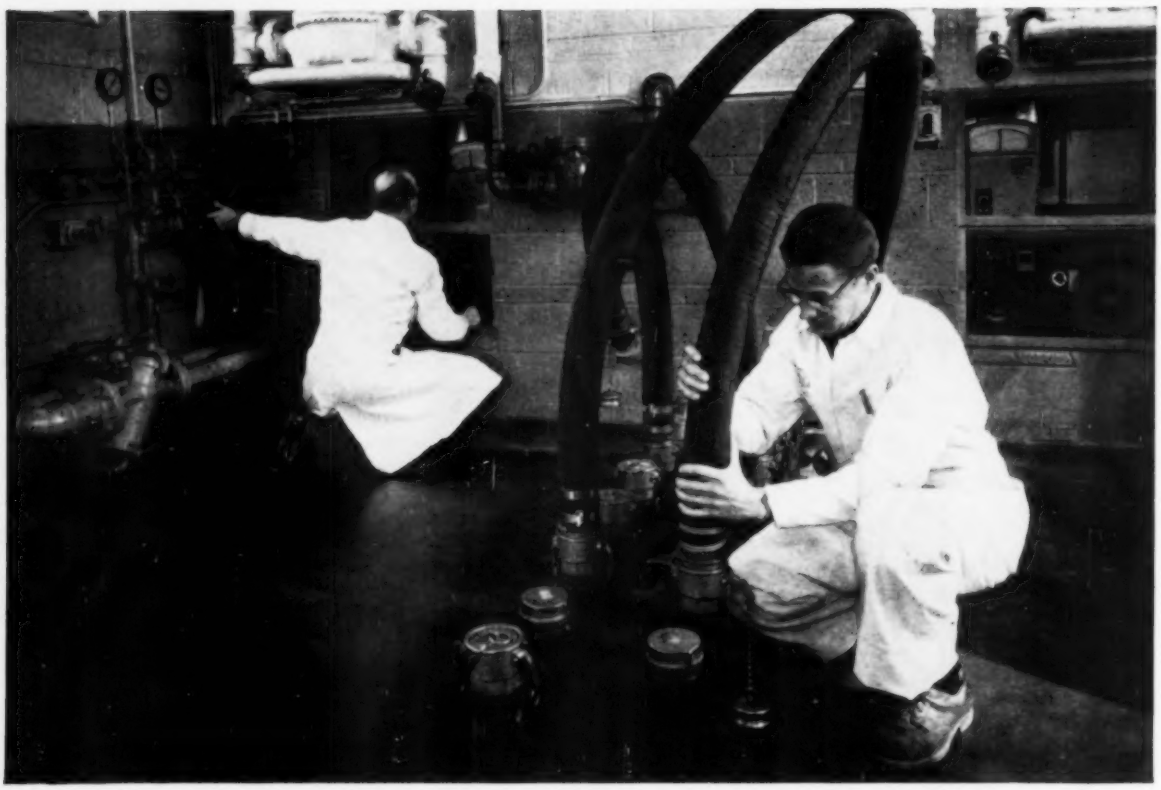
This then is the future . . . but how far is the future? Is it contained in the next 100 years . . . or less? One thing is certain though. In this world of rapidly advancing technology, the refiner who uses yesterday's technology to build tomorrow's refinery or slackens the efficient pursuit of research will seriously endanger his competitive position and cannot long endure.

Forward thinking then is the keynote of progress. To dwell long on history is folly. The only value in history is that it serves to point up the tremendous gains that our infant technology has made and to indicate the fabulous century ahead as we can further develop. It can be observed that those who reflect on history and are motivated by the actions of others can only rarely hope to meet the competition. It is those who dare lead, and have a reason for it, that usually carve the future and set the pattern for the followers.

In all the predictions for the future there is one factor ever present . . . people. In looking to the cenutry ahead, it might be well to keep in mind the words of Lewis Mumford . . . *"No matter how marvelous our inventions, how productive our industries, how exquisitely automatic our machines, the whole process may be brought to a standstill by its failure to engage the human personality or to serve its needs."*

ETHYL ADDITIVE RESEARCH ...The final answer is on the road

In 1958, Ethyl's test cars and cooperating car and truck fleets logged over eight million miles on the road in evaluating fuel and lubricant additives.



Here Ethyl technicians control gasoline blending with laboratory accuracy, in quantities up to 10,000 gallons.

Why Fleet Evaluation

Prospective additives for fuels and lubricating oils require extensive testing and evaluation before being made available commercially.

In addition to evaluating their effectiveness on their prescribed job, additives are checked for possible detrimental effects such as reduced valve and spark plug life, engine wear and increased combustion deposits.

Initial screening is performed in the laboratory through chemical and engine tests. But the final answer comes from broad-scale investigation under actual use conditions.

The development of a successful additive requires careful study before it can be marketed with the assurance that overall behavior is beneficial. Durability aspects are perhaps most important since very small concentrations of certain chemicals may either greatly improve or reduce engine life.

As an example, the figure shows data from passenger car fleet work on seven different experimental fuel additives. In this study, exhaust valve life was evaluated under heavy duty road operating conditions.

Blending for Fleet Tests

Fleet work requires large quantities of test fuel that must be blended with laboratory precision to eliminate variations in additive concentrations.

To provide accurate test fuel blends for passenger car and truck fleets, Ethyl maintains blending plants at Detroit, San Bernardino and San Antonio.

At these plants, experimental fuels are put together in batches ranging up to 10,000 gallons. Each blend must be prepared with the care and accuracy that is usually required only for laboratory work.

At Ethyl's Detroit laboratory, precision fuel blending equipment includes two positive displacement pumps, each capable of handling 230 gallons per minute; seven 10,000-gallon storage tanks which are interconnected to fa-

ADVERTISED PRODUCTS, SEE READER SERVICE CARD FOR FURTHER INFORMATION ON

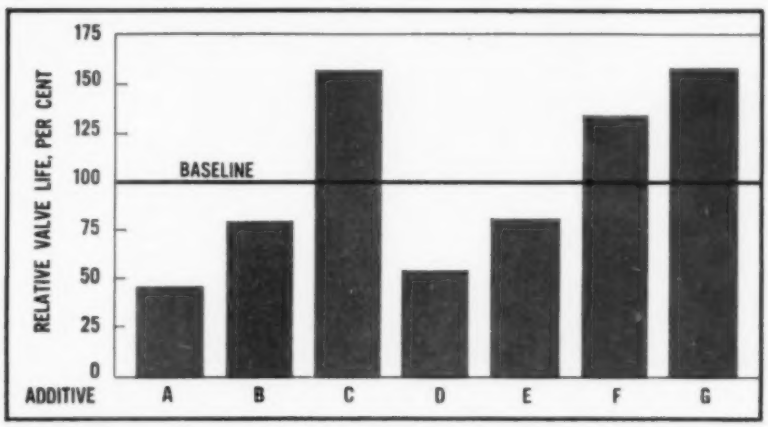
cilitate blending flexibility; and an accurate eductor and weigh-scale system for precise measurement of additives to be used in experimental fuel.

Fleet Tests for New Antiknocks

This equipment permits precise blending of Ethyl's experimental antiknocks for fleet study. The following engine aspects are evaluated on the road:

Inductibility
Engine wear
Oil oxidation
Octane requirement increase
Valve durability
Spark plug life
Surface ignition

Because of Ethyl's fleet work with the new manganese additive (AK-33X), a new antiknock is now on the commercial horizon. In many cases this new product will afford the refiner more economical octane numbers; in all cases it will give the refiner additional chemical octane flexibility for planning future gasolines.



Experimental fuel is transferred to a gasoline tanker.

How Ethyl Research can help you

Painstaking evaluation of every development step from the test tube to the cars on the road assures refiners that all new Ethyl products meet the criteria of commercial acceptability.

Ethyl Research Representatives are in direct contact with such research programs. As a result, they are able to maintain a continuous flow of up-to-date information to customer research people.

If you would like more information about the program that was used to evaluate the new manganese antiknock, contact your Ethyl Representative.

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

ETHYL CORPORATION
New York 17, N. Y.

Ethyl Corporation of Canada Limited, Toronto
Ethyl USA (Export) New York 17, N. Y.

RESEARCH LABORATORIES
Ferndale 20, Detroit, Michigan
San Bernardino, California

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Stainless Steel pipes cool hot acid

AT SINCLAIR REFINING COMPANY,
HOUSTON, TEXAS

This continuous SO_3 sulfonization unit produces a high detergent lube oil additive. The picture shows Type 316 Stainless Steel pipes in the cooler. 98% sulfuric acid enters the coils at about 145°F and is cooled to 105°F by water.

The pipes take punishment three ways: high temperature, acid corrosion, and erosion. At first, some of the pipes were made of a less resistant metal but they had to be replaced with Stainless Steel after only eight months. There has not been one sign of deterioration in the replacements or in the Stainless Steel pipes installed originally.

When you install equipment, design it with the right material from the start. If you need strength and corrosion resistance, there is no metal that can match the performance and economy of Stainless Steel. Order USS Stainless Steel through your U. S. Steel representative or your local Steel Service Center.

USS is a registered trademark

United States Steel Corporation – Pittsburgh
American Steel & Wire – Cleveland
National Tube – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
United States Steel Export Company

USS **United States Steel**

What Human Mind Can
Venture a Guess on

Petroleum in 2059 A. D.?

Refining Capacity

. . . 1958 — 9.6 million bbl a day
. . . 1947 — 5.4 million bbl a day
. . . 1931 — 3.7 million bbl a day

Dr. C. Vernon Foster, *Consultant*
Dr. Hermann C. Schutt & Assoc.
Boston, Massachusetts

Dr. R. N. Maddox
Head, School of Chemical Engineering
Oklahoma State University

A CENTURY AGO, COLONEL EDWIN L. DRAKE completed the world's first commercial oil well. This marked the founding of an industry that has grown at a fantastic rate in its 100 years of existence. Oil was first used as a replacement for whale oil to light the lamps of the world. Introduction of the automobile brought a coincident demand for a combustible fuel which was easily contained and transported. Oil, being liquid, was much more suitable than coal. Modern day refineries are constructed with their principal product still being gasoline for consumption in transportation. We have begun, however, to see a shift in refinery production. **Steadily increasing quantities of oil are being converted to more valuable materials.** What does the future portend for the refinery industry? With our technology developing with compounded interest, how will the refining industry adapt itself to the changes that will be required during the next century?

Looking From 1859

Before we take a look into possible changes in our industry during the next century, let us take a backward look at the 100 years just past. What man, standing beside Colonel Drake's well in 1859, would have visualized a petroleum industry producing and refining some 5 billion bbl of oil each year; converting crude petroleum into products with hundreds of uses in our daily lives; effectively utilizing in its daily operation television, high speed computers, automatic control systems, telemetering, catalytic cracking and hundreds of other techniques that no ordinary man could have believed ever would exist. From the simple batch stills and one-man plants of the 1870's, the refining industry has grown to a huge industrial complex of pumps, heat exchangers, distillation and absorption towers, extraction units and catalytic cracking towers that literally spreads around the world. With our science and technology still in their infancy but on the threshold of maturity, what human mind can venture a guess at the developments of the next 100 years?

World Energy Requirements

Through the years the petroleum industry has supplied a steadily increasing percentage of total world energy demand. In 1959 almost half of the total world energy consumption was derived from petroleum. Fig. 1 shows the growth in energy demand by the world's population. It also shows the contribution of various energy sources to supply this demand. Though coal shows a steady and consistent increase in production, in recent years, it is oil

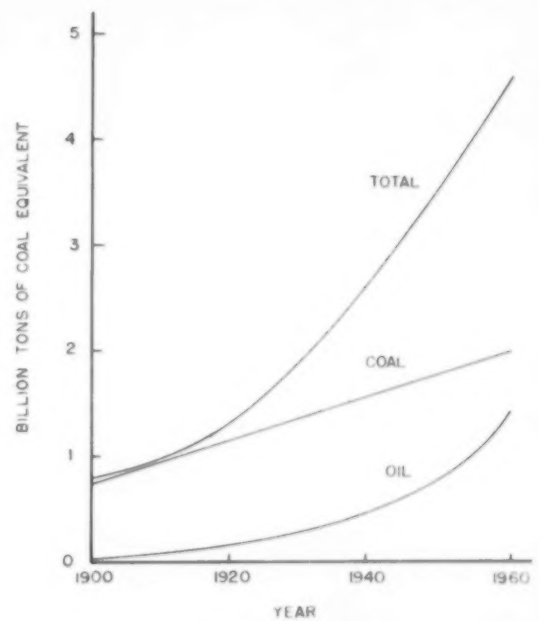


FIG. 1. Energy consumption.

that has supplied the energy necessary to satisfy the tremendous increase in total demand.

One result of this increased production of oil has been a coincident increase in refining capacity. In 1931, refining capacity in the United States was 3.7 million bbl per day; in 1947, 5.4 million bbl per day; and in 1958, 9.6 million bbl per day.[3,4] An interesting phenomenon in connection with this increase in refining capacity is apparent when one considers the total number of operating refineries. Rather than a steady increase, this number shows a peak during the years of World War II with a drop-off that obviously has been compensated for by increased throughput in the refineries now operating. This trend gives us **a clue as to one feature of the twenty-first century refinery** . . . It will be **BIG!**

Cause of Demand Increase

In order to visualize potential energy requirements during the next century, we must consider the source from which the demand for energy stems — people. In the sense of energy consumption, we must ask two questions. How many people will there be and what will be their individual energy needs? Brown[1] treats this question rather thoroughly. At the present time, there are approximately 2.6 billion people in the world. By 1980, the number will have grown to approximately 3.6 billion. With an estimated growth of 1 percent per year, which is actually a conservative growth rate, we should expect nearly 5 billion people by the year 2000 and almost 7 billion by 2050. On the basis of more realistic increases, the population becomes almost 12 billion people by 2050.

Present day energy consumption is approximately equivalent to 1.5 tons of coal per person. This is a very misleading figure because the per capita rate of consumption in the United States is approximately 9 tons per year. What does the future hold? Will per capita energy consumption in the world continue to increase as it has over past years or will there be a decline? Best estimates today are that there will be a tremendous increase in the per capita demand for energy. Coupling this with the population estimates of Brown yields a curve with the general shape of the total energy curve in Fig. 2. If we accept an estimate of 7 billion people in 2050 and an annual per capita energy consumption of 5 tons of coal equivalent, we arrive at an estimated world energy requirement equivalent to 35 billion tons of coal per year. Compared with our present annual production of approximately 4.0 billion tons of coal equivalent, this is truly an astronomical number. This, however, is based on a conservative estimate of the number of people in the world in 2050. Using the same per capita energy consumption figure of 5 tons of coal equivalent per year and the more realistic estimate by Brown of 12 billion people, we arrive at a total energy consumption of 60 billion tons of coal equivalent per year.

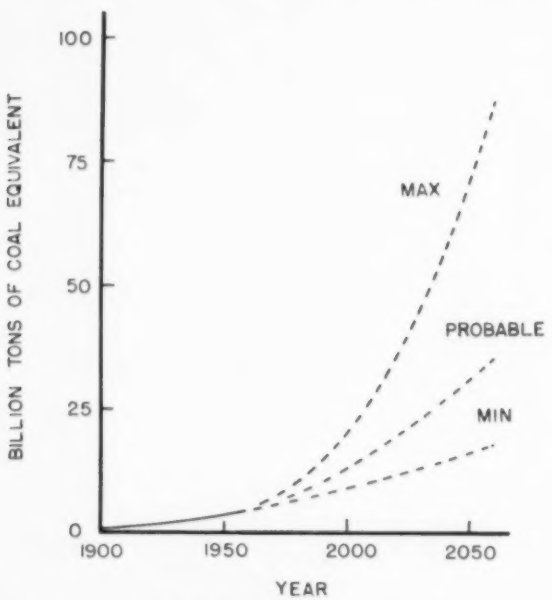


FIG. 2. Estimated requirement.

Energy Demand . . . 2059 A.D.

Who is to say what the per capita average energy consumption will be 100 years from now? The estimate of 5 tons of coal equivalent per year could well be in error by a factor of 50 percent. If in error on the high side this would mean a total annual energy consumption for the 7 billion people of 17½ billion tons of coal equivalent. If the estimated 5 tons of coal equivalent is in error on the low side and using the high figure for population of 12 billion people, the total annual energy consumption in 2060 could be as high as 90 billion tons of coal equivalent.

To put these estimates in more meaningful terms, let us consider the rate at which present energy demand would be compounded at an annual rate in order to achieve these rates of production at the end of 100 years. For the low figure of 17.5 billion tons of coal equivalent per year, our present rate of 3.4 billion tons of coal equivalent would have to be compounded at the rate of 1.6 percent per annum. To reach the high figure of 90 billion tons of coal equivalent, our present rate of production would have to be compounded at the rate of approximately 3.4 percent per annum. Neither of these figures represent an unrealistic growth potential. This is especially true when compared with the present rate of growth of approximately 6 percent per annum for electric power producing facilities in the United States.

Energy Sources . . . Where?

If we accept the total energy requirement curve of Fig. 2, our first question is: Where is all this energy going to come from? At the present time, there are eight possible sources to supply all or part of future energy requirements.

1. **Oil,**
2. **Coal,**
3. **The sun,**
4. **Nuclear fission (uranium, thorium, plutonium, etc.),**
5. **Nuclear fusion and fuel cells,**
6. **Wood and other vegetable matter,**
7. **Hydro-electric power,**
8. **Wind and tide.**

Which of these show the greatest promise of developing to such an extent that they can supply an appreciable portion of our future energy demands? Wood and vegetable matter can immediately be discounted. Their principal future value will be as foodstuff rather than as an energy source;

also, they are not conveniently transported and the supply is limited by available farmland.

Hydro-electric power does not have a rosy future. A large share of available sources are presently developed. Some remote regions do show promise for future development but we shall be forced to content ourselves with only a small fraction of total energy requirements supplied by hydro-electric sources.

Wind and tide, likewise, are not likely to be major energy sources. Winds can be very irregular in most sections and tremendous storage capacity would be required to carry over from one windy period to the next. Tides flow in and out on a regular basis but the authors believe that they will not soon be a major source for power generation.

Direct conversion of solar energy shows great promise in some areas. Recent developments indicate real potential for use of solar energy in home heating. It is quite probable that the next 50 to 100 years will see further developments in this area, and significant quantities of our future energy demands will probably be supplied by direct conversion of the sun's rays. Assuming that an appreciable portion of home heating and cooling requirements are converted to utilize energy from solar sources, we may see as much as 15 to 18 percent of our total energy requirements supplied by direct conversion of solar energy.

The foregoing discussion leads to the inevitable conclusion that the major portion of our future energy requirements must be supplied from the organic fuels, coal and petroleum in combination with the nuclear processes, fission and fusion. To further assess possible contributions to the total energy supply from these two sources, we must consider availability.

Hubbert[2] has estimated **total available petroleum** reserves at **1250 billion bbl** for the **entire world.** Converted to tons of coal equivalent, this becomes approximately 280 billion tons of coal. Based on present rates of production and exploration, and extrapolating these into the future, Hubbert arrived at a bell-shaped curve similar to that in Fig. 3 for past, present and future petroleum production. The continuous portion of the curve is based on past experience in oil production. The dotted portion of the curve is Hubbert's estimate of future oil production. Total area under the curve represents the estimated 1250 billion bbl of oil estimated as the total world reserve. Fig. 3 indicates that the **maximum oil production rate** is likely to be reached around 1975. Peak production of oil is approached so rapidly because of the tremendous demands presently being placed on the oil industry. Hubbert pointed out that an error of as much as 30 percent in the estimate of total U. S. reserves caused only a six-year error in the time in which maximum oil production would be reached in the U. S. A.

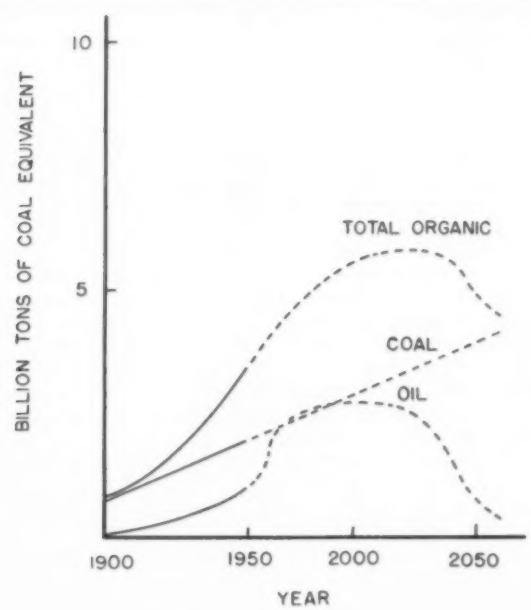


FIG. 3. Estimated production.

Though some argue with the maximum level of the plateau and others with the extent of this plateau, one fact is inescapable. **RESERVES OF PETROLEUM ARE DEFINITELY FINITE. SOMETIME THEY MUST BE EXHAUSTED.** When that time will come, no one can say for sure, but come it must. If Hubbert's estimate of future total oil production is even reasonably accurate, then a comparison of Fig. 2 and 3 shows very clearly that something other than oil must supply a large share of our future energy demand.

Fig. 3 also contains an estimated curve for the rate of coal production. If the complete curve for coal were shown on Fig. 3, it also would represent a bell-shaped curve. The rise to maximum production would not be so sharp as for oil. The curve appearing on Fig. 3 is a straight line because we have shown only a small portion of the bell-shaped time-coal production curve. Coal production is increasing because of a combination of demand and a more competitive position brought about by increased costs of production for petroleum fuels. If we compare total energy requirements from Fig. 2 with available supply from organic fuels from Fig. 3, we see that after the next 50 years or so the combined total production of coal and petroleum cannot possibly suffice if the world's total demand for energy increases as previously postulated.

Nuclear Energy

The simple fact is that sometime within the not too distant future nuclear sources of energy must begin to supply a rapidly increasing percentage of the total energy requirement for the world. Energy from nuclear sources is today competitive in some quarters of the globe. As petroleum production costs go up, and certainly if oil and coal are not supplied in sufficient quantity to meet the demand, nuclear sources will necessarily begin to supply the energy required.

As the cost of power from nuclear sources becomes competitive with that derived from coal and petroleum, we will see a transition in the generation of electricity. Plants will become larger and more efficient. They will use nuclear energy as the heat source for generation and coal and petroleum will gradually drop out of the electric power generation picture. However, as coal and petroleum lose out in the electric power generation race, they will find an increased demand for use in individual transportation. It is probable that, for many years to come, the ease of transportation and ready availability of organic fuels will dictate their use in motorized transportation.

Petrochemical Future

Organic fuels are used for other purposes than the generation of power. Though petrochemical production is still in its infancy, trends in production indicate that more and more of the gross crude oil production will be converted

THE CENTURY AHEAD

into these specialty items. Today, approximately **1 percent of U. S. crude oil production** or 25 million bbl per year go to the production of these specialty items. Currently, the growth rate of the petrochemical industry is approximately 6 percent per year. If this rate of growth continues for the next century, then **in 2060, approximately 8.5 billion bbl of petroleum** will be needed to supply petrochemical demands. If we assume a more conservative growth rate of 4 percent per year for the next century, petrochemical production in 2060 will consume 1.25 billion bbl of oil annually. Looking again at Fig. 3, we see that the combined production of organic fuel in 2060 is postulated to be approximately 25 billion bbl of oil. From the growth figures above, we see that somewhere between 5 and 35 percent of organic fuel production will be converted to specialty items with the remainder available for consumption in energy production.

Greater Demands on Energy Sources

Petrochemical products are, in the main, specialty items that require more processing than does the fraction of petroleum sold for use as a fuel. The tremendous increase in demand for petrochemicals will require an even greater expansion in refinery technology. Processing equipment will be greatly complicated. A large portion of refinery output will be sold as pure components subject to rigid specifications.

Where will the refiner turn with petroleum production dropping, as postulated in Fig. 3, and demand for liquid fuels still increasing? The most obvious answer is that he will turn to coal, tar sands and oil shale as the most promising materials from which to manufacture the liquid fuels he must supply. Since these materials are not so readily and economically transported as is crude oil, the refinery of the future will be located much closer to its raw material supply.

Physical Effect?

Because natural gas and liquid petroleum are easily transported, the refinery of the future will probably be equipped to handle gases, liquids and solids as raw material input either singly or all together. Since materials handling is always a problem with solids, processes such as hydrogenation and Fischer-Tropsch will be utilized to convert the solid materials to gases and/or liquids for processing.

As stated previously, the physical plant will be huge. Throughputs may be gaged in millions rather than thousands of barrels. Energy demands will be fantastic and for this reason, nuclear sources will be utilized for electrical power and process heat input. Because water for process uses is already a problem, we will see process cooling by refrigeration and heat pumps instead of the more conventional cooling towers.

Automation

Process units will be completely automated with only a few very highly skilled men to operate them. Computers controlling the process will take orders for product specification and change operating conditions to produce the desired materials. Product handling will also be computer controlled as will all billing and accounting procedures.

Maintenance

Knowledge concerning corrosion prevention and materials of construction will be much advanced. However, more severe process temperatures and pressures combined with impurities in the raw feed stock will mean that need for maintenance will be higher than today. Improved design techniques and unitized construction will result in a high degree of interchangeability for reactors, heat exchangers, pumps, and other process units. Maintenance methods will also be highly automated and most maintenance problems will be handled without shutting down the unit. Because of these complexities, men in maintenance will be highly skilled technicians and accomplished technologists.

Technology

Conversion in reforming reactions will make extensive use of nuclear radiation, electrostatic generators, and ultrasonics. Jet reactors will be highly refined and operating at high temperatures and high reaction velocities. These changes will result in much smaller reactors with much savings in space. Control of reactions will be much better. A large share of refinery products will be specialty items calling for high purities and excellent quality control.

Engineers

Men qualified and capable of designing, operating and maintaining the refinery of tomorrow must be well trained engineers and technicians. They must have a broad background in the fundamentals and applications of reaction kinetics, thermodynamics, materials of construction, mathematics and radiation chemistry. In addition to formal training and education, they will be required to display a high degree of ingenuity and imagination.

The refinery of tomorrow will truly be a giant industrial complex. It will be a marvelous thing to behold and will stand as a tribute to the men of the oil industry who will have for two centuries made available to the world the benefits of petroleum.

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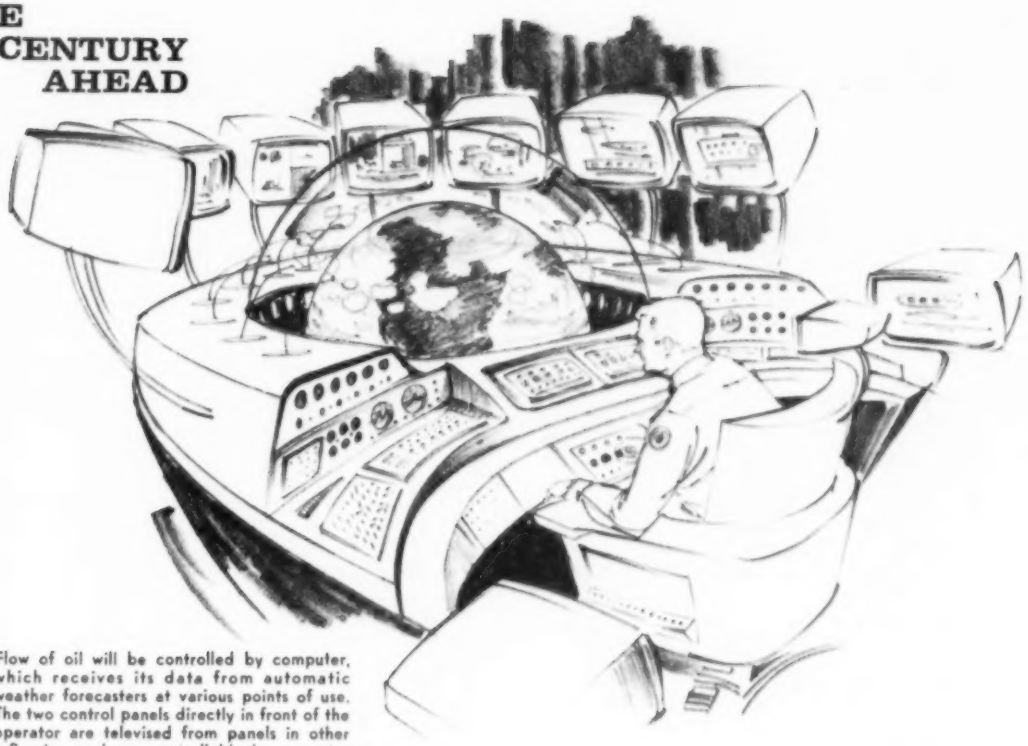
THE CENTURY AHEAD



Flow of oil will be controlled by computer, which receives its data from automatic weather forecasters at various points of use. The two control panels directly in front of the operator are televised from panels in other refineries, and are controllable by a master panel at his finger tips. Monitors are monitoring outlying refineries.

An Engineer Views . . .

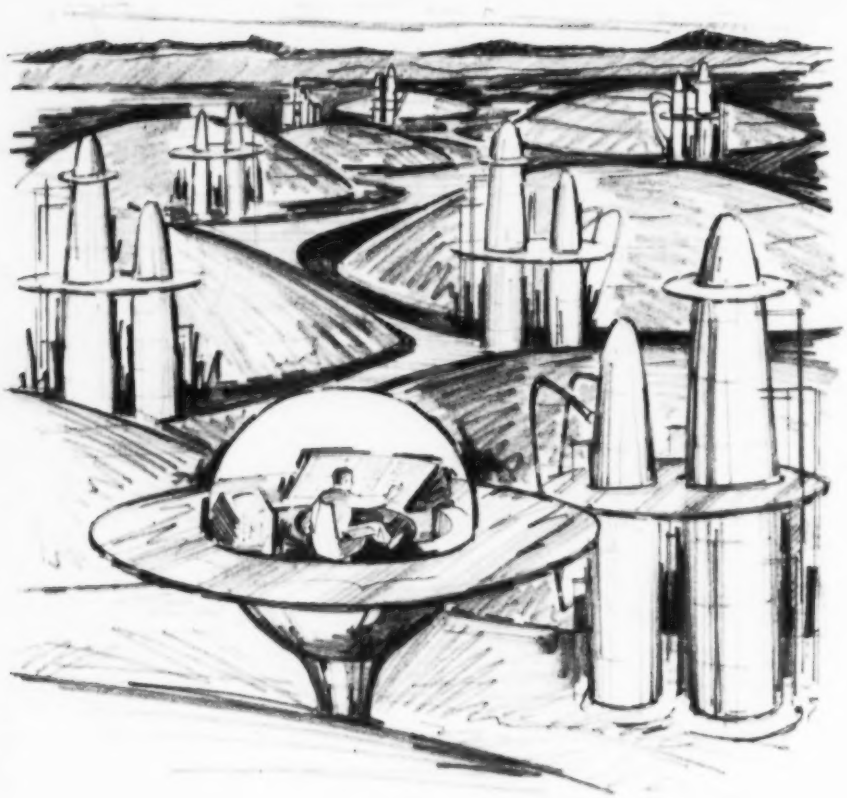
21st Century Petrochemical Plants

E. H. Ivey, Jr.
Dow Chemical Company
Freeport, Texas

No petrochemical plants will exist in the next century . . . for "fossil" chemicals will more aptly term the chemicals based on carbon and hydrogen since raw materials will be not only natural gas and petroleum liquids, but also many other sources of hydrocarbons. Coal, coke, oil sands, tar sands and even oil shale will be used to produce many of the same end products. The basic building blocks of the "fossil" chemical industry can be produced from a variety of different feedstocks. And they will be. Ethylene, propylene, butylene, butadiene, benzene, ammonia, and many others not now of commercial interest, will be produced from a variety of charge stocks the choice of which will be determined by availability and local economics.

"Fossil" chemical plants will grow bigger and bigger! But they will also grow smaller. We will have the supermarket and the corner grocery type of plant. They will all employ fewer people per pound of product — maybe even fewer in total number! But the employees will be more skilled. The large plants will have more specialists, but the jack-of-all-trades won't be dead. They will operate, maintain and administer the small corner chemical plant.

As labor becomes more costly manufacturers will devise ways of reducing the amount required to make a unit of product. Of course, instruments and computers will be used to get the maximum dollar yield from a pound of raw material, but what about the direct cost of operating and maintaining the plant? Better and cheaper materials of construction will be used so that corrosion, abrasion and erosion will not be significant. Fewer pieces of equipment with moving parts will be used. Painting will be **permanent.** Plants just will not need to be maintained as they are now. Years will pass without the need for an oiler to lubricate the mechanical equipment. For the parts of the machines will be **permanently** lubricated at the factory. Good remote control systems and computer type control systems will operate the plants at the optimum by the command of one person sitting in an office. Continuous automatic analysis will ensure that products meet specifications. The plants will cost more to build, but much less to operate. They won't be maintained — just used, and thrown away when they break. In one of the corner chemical plants, one man will be employed for the then-normal 14-hour work week and he will do the entire job. If something goes wrong in the plant that the computer cannot fix, the computer will automatically shut down and call its one-man work force to report the



Processing plant of the future... extremely unitized... operated and controlled by one large central computer system that in turn supervises and controls remote slave units for certain process sections.

trouble. If a pump, heat exchanger or other piece of equipment fails, a manufacturer will be called to bring a replacement, install it and take in the old one on a trade-in basis.

But what will these "fossil" chemical plants look like? And how will common operations be handled in comparison with today's methods?

Transportation of materials. All materials, solids, liquids and gases will be moved by electricity — electromagnetic and electrostatic pumps and compressors. Even solids will be transported in pipelines. It's being done now with solids dispersed in a fluid, and with improved techniques it will become quite common. But what pipelines! Concentric tubes and batteries of them will be used to carry several materials along the same route. Materials of construction which will endure any corrosive condition will be used such as the latest new high temperature alloy, ceramet, or ceramic which works easily, and will withstand temperatures of 3000 C and down to absolute zero.

Heat Exchange. Old shell and tube heat exchangers or old fired tubular heaters or furnaces will be scarce in the plant of the future. Solar or nuclear heat will be used in all direct-fired applications. Heat exchange will be cheaper, better and quicker with the extended surface units.

Distillation. Conventional bubble plates will still be used in some old plants, but most distillations will employ packed or even empty towers. Highly efficient low holdup, low cost extended surface packing will be most common, but the newer, larger plants will use empty, concentric-tube columns of very large diameter — and they will nest a whole battery of towers one inside the other.

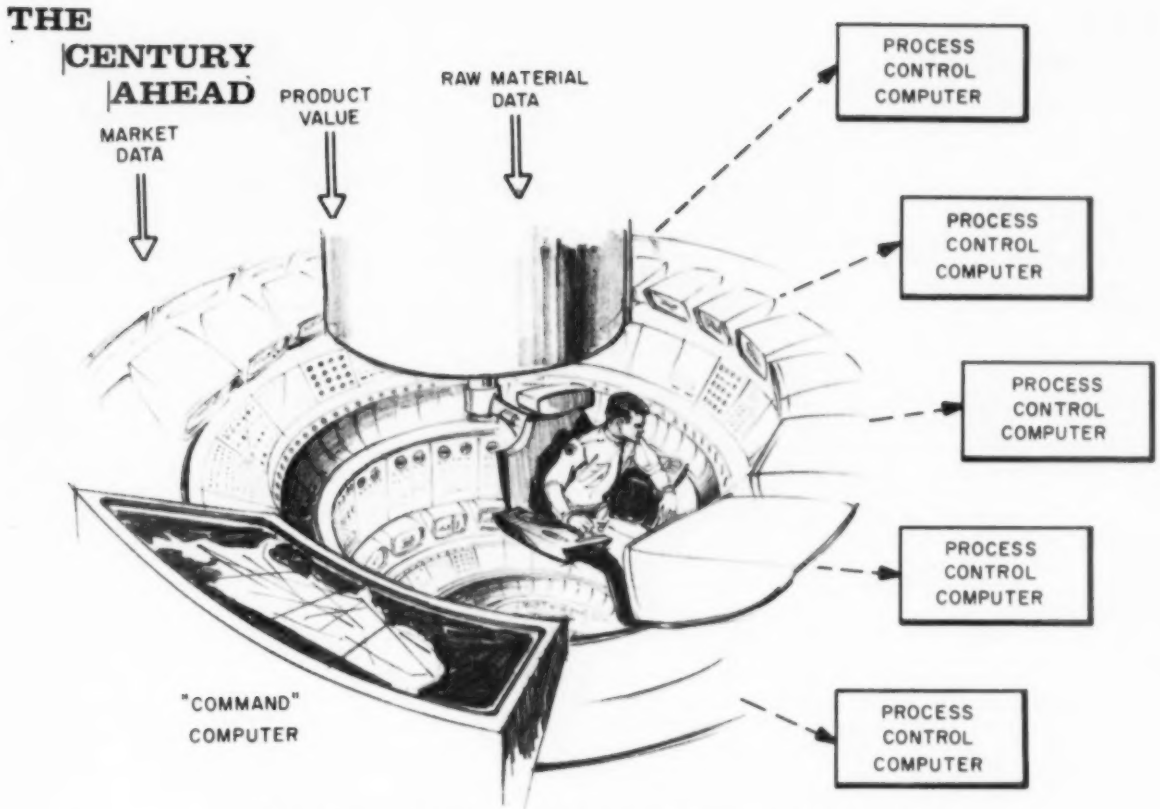
Azeotropic and extractive distillations will still be practiced but they will be given a new twist. Solids as well as liquids will be used as entrainers and solvents.

Storage of materials. Tank farms, bins, drums and warehouses will have long since become obsolete. Plastic-lined holes in the ground will have replaced them.

Plants will grow bigger *and* smaller. Why? The cost of transportation and handling will permit centralized production of only the most expensive products. So, every town will have its own chemical plant or two to supply local requirements of basic chemicals. The plants themselves will be one-man businesses designed to use any source of hydrocarbons to make a number of useful products. The plant will be simple with a minimum number of pieces of equipment but designed to carry out any of the desired processes in the same equipment. To switch from one product to another a prepared program is simply plugged into the master control system and the plant will clean itself out and switch to the new set of control conditions. The catalyst will be pumped out of the reactor and the one required for the new product will be pumped in. After a final 10-microsecond pause to check all controls, the controller will give the signal and production of the new product will begin.

In areas where hydrocarbons are not available, such as the South Pole, CO_2 will be separated from the air and hydrogen obtained from the decomposition of water to start the chain of chemical production.

Present-day experiments and developments can only hint at the innovations which will have occurred in the next century in all phases of plant operations, transportation of materials, solar or nuclear heat exchange, distillation with empty towers and underground storage for materials. But, amid plant streamlining, the 21st century transition from petrochemical to "fossil" chemical will be significant not only scientifically, but because with it, industry changes its name. ★ ★ ★



A master computer dictating orders to subordinate process control computers.

Will the next 100 YEARS bring a . . .

"Push-Button" Industry?

. . . from wellhead to consumer's tank!

Dr. Joseph F. Manildi
The Thompson-Ramo-Wooldridge Products Co., Los Angeles, California

COMPUTER CONTROL of industrial processes is now a reality. Closed-loop digital systems, controlling manufacturing units, are now being utilized in the process industries. The first such installation went onstream in March of this year at Texaco's Port Arthur, Texas, refinery. Several other similar installations will be onstream before the end of this year. Automation, if only in its infancy, has indeed arrived. But what of the future? **What will be the role of digital computers in the refinery of tomorrow?**

Today

Before embarking on a discussion of refineries in the year 2000 or beyond, a proper understanding of process control as we know it today is necessary. It would be useless to speak of master computers dictating orders to subordinate computers which in turn control process units without knowing the extent of computer control at present. For this same reason, a projection of thoughts on future computer control would serve no purpose without first taking note of the present state of the art in instrumentation, from which computers receive information, and forecasting future developments in this field.

The computer at the Texaco installation is being used for closed-loop control of an 1800 bbl per day catalytic polymerization unit. **This is the first such application of a digital computer in the process industries.** Heretofore, equipment has been used to log data which is subsequently analyzed in order to establish better manual control procedures to achieve more efficient performance. This computer installation, on the other hand, *receives inputs directly from the process unit*, reduces the data, performs computations using the data, and *feeds back signals directly to the unit's controllers* which make appropriate adjustments in the process. Achievement of closed-loop control, although a big step in process control automation, may be merely the starting point for tomorrow's so-called "push-button" refinery.

Reduced Costs and Profits

Computers, like any other capital investment, must be justified by a payback within a reasonable period of time. The system must increase profits or reduce costs appreciably or it has no economic justification, and hence no value, to the refinery. Higher profits may be realized through increased throughput, better quality control, or reduced costs resulting from more effective use of materials or equipment. For this reason, the most promising

THE CENTURY AHEAD

applications of computer control in the refining industry today are on the larger units which contain many variables. Further refineries, however, will include several computers, some larger and much more expensive, and some smaller, less complex, and hence less expensive.

New Design Concepts

With the acceptance of the digital computer as the central unit in refinery instrumentation control will come the redesign of refineries themselves to take full advantage of the capabilities of computer control. Knowledge acquired on computer controlled processes of today will influence the methods used in development of new plants which incorporate the same or similar processes.

Intermediate storage capacity, for example, will be reduced in future refineries since the computer will direct the flow of material from one unit to the next accurately controlling the volume and accepting only that amount of material which can be handled by the unit. This will permit more precise design of process units and lines connecting the various processes by eliminating the need for surge capacity. As units are reduced in size, it is conceivable that their complexity will be reduced and their ultimate cost lessened.

At the present stage of computer control development, processes are controlled by signals which adjust set points on the unit's controllers which in turn exercise direct control over conditions within the unit. As advances are made in computer research, it appears likely that these controllers will become superfluous; their function will be incorporated within the computer itself. Some controllers could be replaced today, and others may be needed for some time to come, but the savings involved when regulatory control functions are handled directly by the computer will surely be substantial.

New processes will be developed during the coming years to replace the proved processes of today. Some of these have been under study in research laboratories for years and are now awaiting technological advances which will justify their use on an economic basis. Digital computer control may be the key to economic justification of such processes.

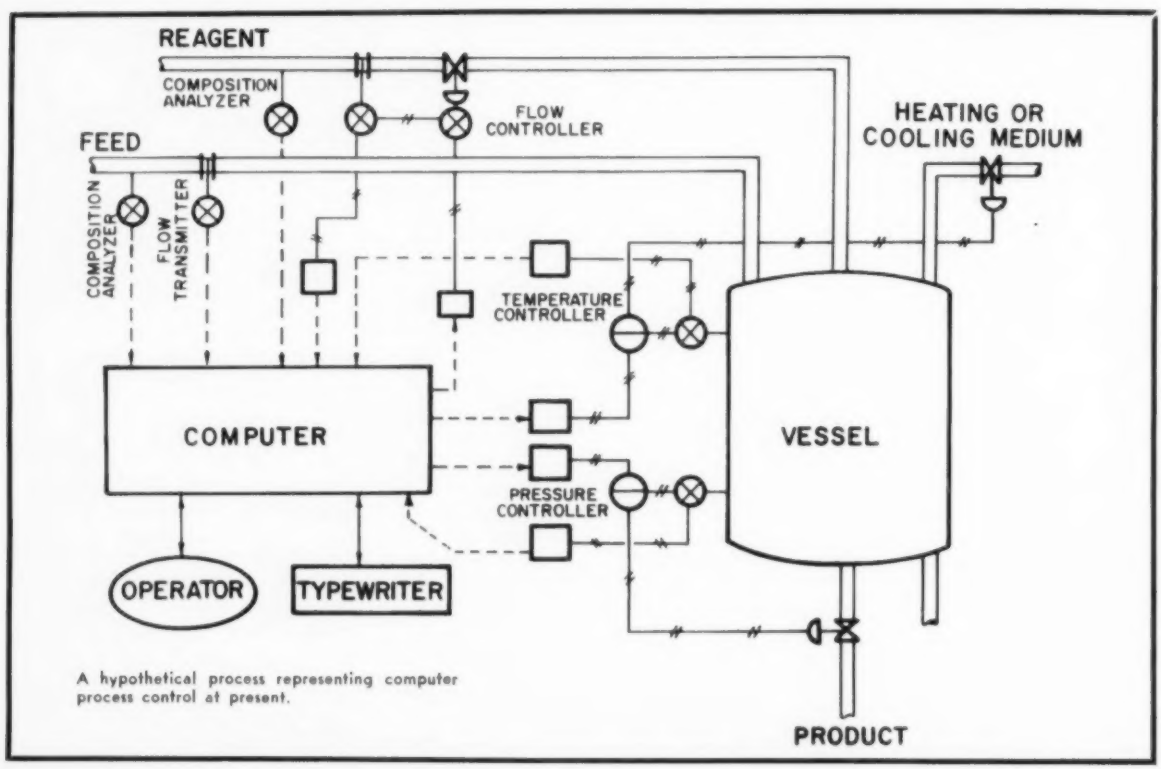
Shale oil refining, for example, may become a reality in the not too distant future as economical processing units are designed around computer control. This would open vast reserves of oil known to exist in the western part of the United States, increasing our petroleum supplies many-fold. Research in shale oil recovery and processing has been conducted for several years. Computer control could well be the long-sought answer to this pressing problem.

"Immeasurables"

Great strides have been made in the past few years in the development of process instrumentation. Many properties still defy accurate measurement, but continuing effort will lead to the development of instruments which measure variables heretofore considered "immeasurable." Many different types of continuous stream analyzers, for example, are now being used in increasing numbers in refineries throughout the world. These include gas phase chromatographs, infrared and ultraviolet analyzers, X-ray and mass spectrometers and continuous differential refractometers. Many more advanced instruments are available for the measurement of density, viscosity, dielectric constant, pH, and conductivity, among other variables.

Where Does the Engineer Fit?

Computer control will permit more effective use of available engineering talent. The process engineer will be freed from the routine tasks he performs today so that he may focus his attention on the total control problem, including both the technical and eco-



A hypothetical process representing computer process control at present.

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nomic aspects of process operation. The plant operator will find himself working in new surroundings as time goes on. With the advent of computer control will come centralized control. Computers operating several processes, even entire plants, will be housed in one control room. This will result in a substantial change in the functions of the operator. His job will be to watch over the computers and take proper action if and when a malfunction occurs, although today's computers have already proved that reliability is no longer a major problem. In addition, the operator will communicate with the computer, requesting special information of one kind or another and inserting laboratory or other such data as circumstances dictate.

Though computer systems in use today have not caused a reduction in the labor force, future systems will so completely automate plant operations that a cut in manpower requirements will be inevitable. The computer, by taking over the minute-by-minute, hour-by-hour control of a process, will allow the operator more time to perform more useful jobs, thus permitting one man to do the work now done by several.

Refining — 2059 A.D.

The refinery of the future will differ greatly from the refinery of today, just as today's plant, with its towering columns and mammoth cracking units, bears little resemblance to the coal oil plants of a century ago. The degree of computer control involved in future refineries will vary from plant to plant, but it is conceivable that the larger refineries will employ several hierarchies of computers for overall control.

Master Brain

On the highest level will be the "command" or "strategy" computer which will dictate orders to the smaller control computers connected directly to the various process units. This master computer will determine detailed objectives of each of the units and transmit information to the control computers which will adjust the various units involved to fulfill the objectives sent down from above. Each unit or group of units may contain different levels of computers, each receiving information from the one on the next highest level. The trend toward centralized control, already evident in today's plants, will reach its peak with the installation of the "command" computer system.

Tank Farms — Eliminated

Storage of both products and raw materials in future refineries will be reduced drastically, and in some cases eliminated completely, when all phases of the refining process are linked by computer control. Ultimate control within the plant could be accomplished by combining information on market conditions with control of the overall plant operation. This information could include hour-by-hour price changes, daily marketing data such as orders received and deliveries scheduled, and predictions of market demands days, weeks, or months ahead.

Overall Coordination — 2059 A.D.

It is also conceivable that the day will come when the entire petroleum industry will be automatically controlled. **Crude oil** could remain in the ground until it is needed to fill requirements at the refinery. This would minimize the need for field storage facilities. At a signal from the master computer far removed from the oil field, the crude would be allowed to flow into the pipeline and thence to the refinery where process control computers would take over to direct it through the entire processing cycle, routing the finished product to its proper destination. **Products** would leave the refinery through other pipelines for delivery to terminals in the company's marketing

THE CENTURY AHEAD

areas. **Chains of service stations** in metropolitan areas would be connected directly by pipeline to these terminals, and computers would allocate the products according to the requirements of the various station and make deliveries directly into the station's pumps. **A small computer** on each pump would then control final delivery of the product into the customer's gas tank, and signal the terminal that more product will be needed for the next customer. **Thus the complete petroleum cycle, from the source bed deep in the earth, through the refining process, to the ultimate consumer, could conceivably be handled by computers.**

Large companies with several refineries in widely separated parts of the country could be operated under one master plan through computer control. The many economic factors involved in the selection of crude to be processed in a certain refinery or marketed in a certain geographical area could be fed into the master computer and instruction sent back within moments for proper routing. Blending of crude as it leaves the well or as it enters the refinery could also be controlled just as product blending is controlled within the plant. Control computers could also be utilized in start-up, shut-down, and turnaround operations on the various process units to facilitate additional savings by reducing costly down-time.

Technology For . . .

Development of such an elaborate system as that described above requires far more than mere hardware. Engineering studies must be increased, major technological advances must be accomplished, and research and development of a magnitude never before known in industry must be initiated. Computer manufacturers will have to meet the challenge of providing not only computers but entire systems designed with the overall project in mind.

Closed-loop control of refining processes has been proved. If the various modes of computer control are as successful as it appears they will be over the next few years, the time will come when every plant contains several control computers of various sizes and types. The net result will be a great improvement in the flexibility, reliability, and economics of refinery operation. Technological advances in computer control will be associated with developments in the instrumentation field, and as these technologies advance, **"push-button" refineries will become realities.**

* * *

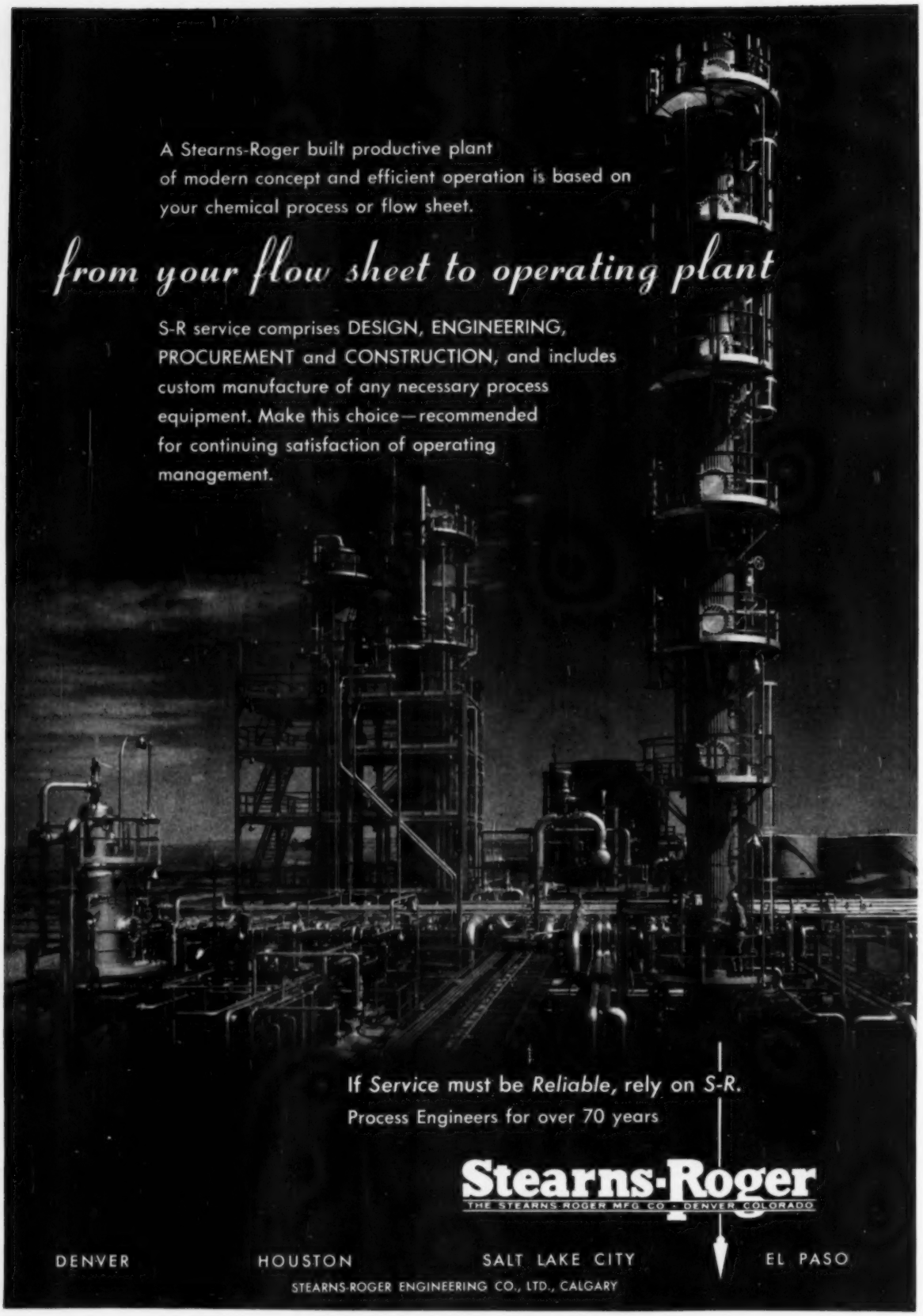
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FIG. 1. Preparation of patient for resuscitation: (1) Remove false teeth or other foreign objects such as gum or tobacco from mouth; (2) place the patient in a supine position with a pillow or folded blanket under his shoulders; (3) cover with blanket for body warmth; and (4) check for leaks around mask caused by facial contours or injuries.

Immediate action is vital in furnishing . . .

Breath of Life for Asphyxiated Refinery Employee

The most effective therapy is oxygen given by a positive-negative pressure resuscitator. It breathes and exhales for the patient automatically

William E. Doering
National Cylinder Gas Division of Chemetron Corporation
Chicago, Illinois

WITH the large number of potential causes of asphyxiation present in today's refinery, those responsible for plant safety must know when and how to administer oxygen and train personnel in the use of resuscitation equipment. The importance of immediate oxygen administration in saving the life of an employee near death from acute asphyxia is generally recognized throughout all industry by safety and medical directors. This vital emergency measure can be easily provided by a refinery that has on hand: (1) easy-to-use accessible resuscitator, in top working order and with an adequate oxygen supply, and (2) employees in the vicinity familiar with the equipment.

Danger Sources

Leakage of toxic fumes such as hydrogen sulfide, or carelessness in entering a storage tank are asphyxia hazards in a refinery. According to API statistics, tank gagers have been especially prone to asphyxiation when they neglect to wear the proper equipment on the job. Other refinery hazards include fumes from hydrocarbons, inert gases, hydrofluoric acid fumes, and sulfuric acid fumes. Hydrogen sulfide constitutes one of the greater dangers, since this gas is between five and six times as toxic as carbon monoxide. Possibility of drowning constitutes another asphyxiation hazard, especially in work on barges.

Use of additional electric equipment increases chances of electric shock, another asphyxiation danger. Even a mild electric shock, usually shrugged off by a healthy employee, can paralyze the respiratory centers and thus kill a person with a cardiac condition. In addition, there is a number of causes not directly related to the employee's job: Many workers suffer from cardiac conditions, high blood pressure, circulatory ailments, asthma, emphysema, and other ailments that make them asphyxia risks, especially when these ailments are aggravated by on-the-job conditions.

The preceding factors may cause critical asphyxia, where breathing stops completely and the vital centers of the victim's body rapidly become deprived of the oxygen required to maintain life. There is no facility for storing oxygen anywhere in the body. Therefore, resuscitation must be administered immediately and a physician summoned. Any delay in treatment may result in the death of the patient; approximately eight minutes of total oxygen deprivation will cause permanent damage to his central nervous system. Asphyxia should not be confused with unconsciousness. When the patient continues to breathe, although unconscious, artificial respiration is not necessary. Even though breathing during unconsciousness is laborious, irregular, or shallow, the indicated treatment is normally simple oxygen inhalation.

It is now generally believed that the most effective therapy technique for asphyxia is the administration of oxygen through a resuscitator that provides positive and negative pressure. Such equipment actually causes the patient to breathe, supplies pure oxygen during the inhalation phase, and automatically exhales for him. When the patient begins to breathe by himself, the resuscitator can be used as an oxygen inhalator. This type of resuscitator is the most common in hospitals, industrial plants, and first aid and rescue services.

One resuscitator was designed especially for emergencies in the industrial plant. Simple to use, it automatically adjusts to the volume of the patient's lungs and instantly signals to the operator if the patient's throat or trachea is obstructed and oxygen is not reaching the lungs. Safety release valves make it impossible for the patient's lungs to receive any pressure beyond a safe amount. This resuscitator can be applied instantly through a mask over the mouth and nose.

Preparation of Patient for Resuscitation

A resuscitator or any method of artificial respiration is completely useless if the oxygen cannot reach the patient's lungs because of obstructed passageways. Proper preparation of the patient for resuscitation will help secure an open

path to the lungs (Fig. 1). According to medical authorities, unless the condition of the patient prohibits, he should be placed on his back with a pillow or folded blanket under the shoulders. This position extends the head in a downward position which helps clear the air passageways. It places the stomach in a lower position than the patient's throat and prevents its contents from obstructing the flow of oxygen. The supine position also enables the patient's chest to rise and fall freely at maximum depth during resuscitation (Fig. 1).

To prevent the tongue from blocking the throat, the tongue should be drawn forward and a wire airway gently inserted behind it. If excessive mucus or vomitus is present in the throat or mouth an aspirator, which should come as an accessory with the resuscitator, should be used at once to suck out the obstructing matter.

The effectiveness of an automatic resuscitator depends on an airtight circuit with the lungs of the patient.

When the patient has extreme facial contours or facial injuries, which prohibit the mask from being sealed on the face, a dampened cloth or towel placed around the edges of the mask and cushion will insure a proper seal.

Because it is usually necessary to give oxygen at the site of accidents, a light portable type of resuscitator should be quickly available to every working area. It is absolutely essential that the resuscitator have two cylinders so that a new cylinder may be fitted during protracted administration. This factor will help insure an adequate oxygen supply during resuscitation.

Equipment should be designed to operate with enough tubing from the cylinder to the mask to enable the rescuer to reach a patient in a remote, hard-to-get-to location. A dual outlet on the pressure regulator is another valuable asset; it allows the rescuer to help the victim in a contaminated area while he wears a mask to protect himself.

As a further aid in rescue operations, a portable resuscitator can be strapped on the rescuer's back, allowing the rescuer to crawl through narrow spaces, with both hands free for moving debris and performing the required first aid services.

First Aid Training

Manual artificial respiration methods and the resuscitator, its operation and maintenance, should be familiar to all those directly responsible for safety of personnel. These personnel should include every doctor, nurse, and rescue worker in the plant. In addition, because time is such a vital factor during critical asphyxia, personnel engaged in plant protection work and electricians and foremen should also receive training in its use.

An effective training program should begin with an introductory formal lecture by the safety director or service representative of the manufacturer. Inexpensive training aids which simulate actual conditions should be supplied with each unit, and supplementary devices are available. In addition to the lecture, the personnel should see the resuscitator in operation and practice with it themselves. A recommended follow-up procedure would be a monthly refresher talk by the safety director or doctor, after which the resuscitator can be demonstrated and used. This training program involves little time, and can pay off in lives in an emergency. Training should make rescue procedure completely automatic and eliminate the need to consult literature or instructions in time of emergency.

Care and Maintenance of Resuscitator

Effectiveness of a resuscitator depends on the two basic components: (1) The resuscitator itself, including its mechanism, hose, and mask, and (2) the oxygen cylinder and its contents. The mechanical section of the resuscitator should

FIG. 2. Oxygen is administered through a positive-negative pressure resuscitator, which breathes and exhales for the patient automatically.

be repaired and adjusted only by the manufacturer. Since any mechanical component can go out of order, it is vital that all resuscitators in the plant be given periodic checks.

One vital factor in the care of resuscitators — never use oil in or on any part of the equipment because oil in contact with oxygen constitutes a fire hazard.

A resuscitator requires reasonable care in handling. Damage to the working mechanism can result from a fall on a hard surface. When the resuscitator is not in operation, the oxygen cylinder valve should be closed and the oxygen bled off. Thus, if there are any leaks in the connections, the oxygen will not be lost.

After each use, the face cushion, plastic mask, tubing, and bottles should be washed thoroughly in a 20 percent aqueous solution of green soap. Next step is a rinse with clear water. The parts should then receive a second cleaning with an aqueous solution of 50 percent alcohol and be allowed to dry. The same solution can be flushed through the mask opening in the resuscitator mechanism until the lower chamber is clean. A clean-water rinse and alcohol should be used for the resuscitator mechanism. Proper cleaning will prevent cross-infection and help insure trouble-free operation.

Oxygen and Gas Cylinders

Oxygen may be delivered to the resuscitator from a cylinder or from a piped system, a type of oxygen supply becoming more common in industrial plants. Oxygen cylinders should be checked frequently to verify the amount of oxygen on hand. There should be at least two "D" cylinders in reserve. The plant physician should assign the responsibility for regularly checking oxygen supply to one member of the staff. A high-pressure flexible metal hose with proper fittings allows a portable resuscitator to be used with a large oxygen cylinder. With such an adapter, a cylinder of industrial oxygen can be used if the small cylinder supply has been depleted.

No gases other than oxygen or oxygen/carbon-dioxide mixtures, as recommended by the doctor, should be used to operate the resuscitator. An empty cylinder can be replaced with a full cylinder on the portable model while the resuscitator is in operation, without oxygen loss.

The standard oxygen cylinders which may be used are as follows: "D" 12.7 cu ft, "E" 22.05 cu ft, and 'H" 244 cu ft. The "D" cylinder will operate a resuscitator for approximately 10 min, "E" approximately 20 min, and "H" from 2½ to 3 hours. ★ ★ ★

Isopropyl Alcohol Production

Licensed by: The Distillers Company Limited

Data provided by: Stone & Webster Engineering Corporation

DESCRIPTION: Liquid propylene feed stock combined with hydrocarbon recycle is absorbed in 75 percent sulfuric acid in a series of agitated reactors to form a sulfated hydrocarbon solution. This is converted to an acid solution of isopropyl alcohol, ether and polymer by hydrolysis. These reaction products are steam stripped from the acid, neutralized by caustic solution and then condensed.

The crude alcohol is charged to the ether column whose overhead is totally condensed. The bulk of the liquid is used as reflux and the remaining small portion sent to a decanter for separation. From the decanter the ether-rich upper layer is pumped back to the reaction system, and the water-rich lower layer is returned to the column as additional reflux.

The ether column bottoms are pumped to the isopropyl alcohol column where the condensed overhead product is an 87 wt. percent solution of isopropyl alcohol in water. Polymer is withdrawn as a side stream and the water bottoms containing only traces of alcohol are reused in the hydrolyzer-stripper.

The 87 percent alcohol product can be concentrated to 99 wt. percent isopropyl alcohol by adding one more fractionating step.

TYPICAL FEED STOCK AND ALCOHOL YIELD

Feed	65 wt. % propylene
Propylene conversion to isopropyl alcohol	93 - 95%

OPERATING SERVICE FACTOR — 85%

UTILITIES	Per gallon 87 wt. % Isopropyl Alcohol
Steam	26.9 lb
Power	0.19 kwhr
Cooling water	120 gal
Fuel	2,000 Btu

CHEMICALS

Sulfuric acid (as 100%)	0.15 lb
Caustic (as 100%)	0.14 lb

OPERATING PERSONNEL — Five men per shift.

INVESTMENT (U.S. Gulf Coast, 1958)

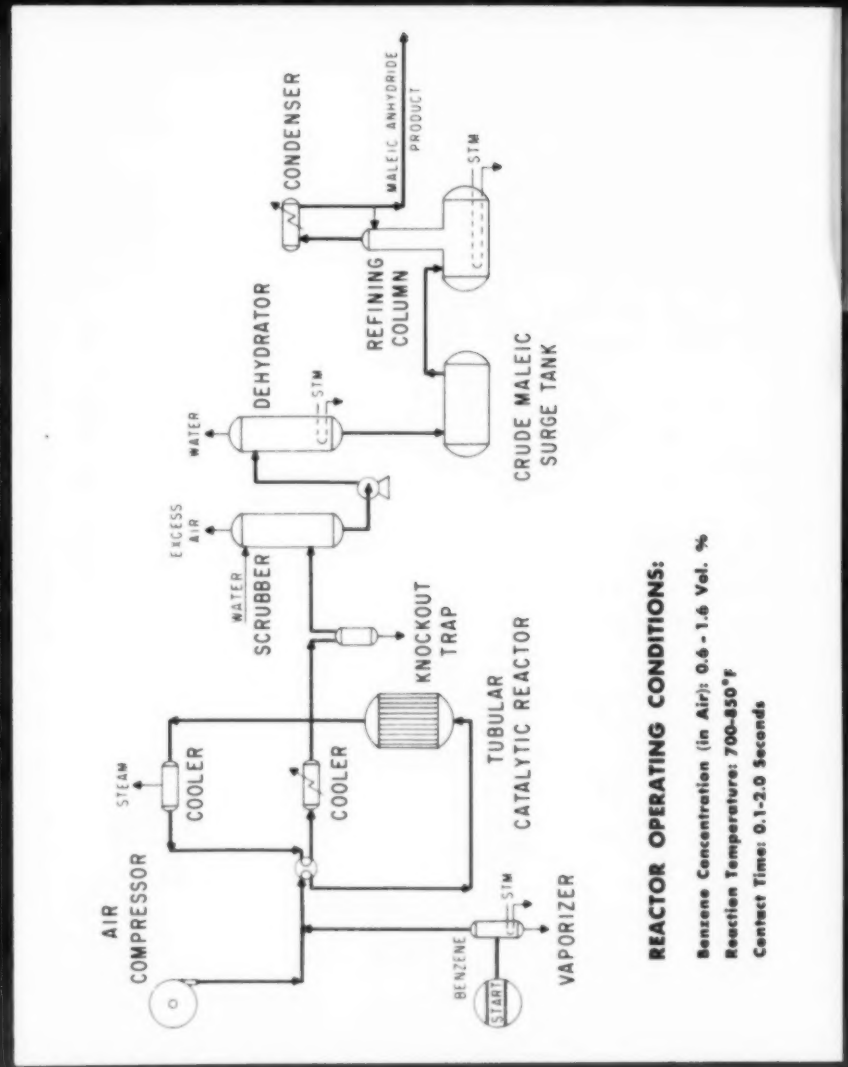
Capacity, M Gal/Yr	Dollars, Thousands
5,000	1,500
10,000	2,200
20,000	3,400

ANNUAL MAINTENANCE

Total for materials and labor: 5% of investment.

Maleic Anhydride

Licensed by: Scientific Design Company, Inc.



REACTOR OPERATING CONDITIONS:

Benzene Concentration (in Air): 0.6 - 1.6 Vol. %

Reaction Temperature: 700-850°F

Contact Time: 0.1-2.0 Seconds

Maleic Anhydride

Licensed by: Scientific Design Company, Inc.

DESCRIPTION: A catalyst developed by Scientific Design Company is used to oxidize nitration grade benzene to maleic acid, which is dehydrated to the anhydride.

Incoming benzene is vaporized in steam heated kettles and mixed with air. The gaseous mixture is preheated and charged to a multi-tube catalytic reactor. Temperature of oxidation and heat removal from the exothermic reaction is controlled by heat transfer medium flowing through the reactor.

The reactor effluent is passed through three coolers in series. The first is a steam generator, the second a feed preheater, and the third uses cooling water.

Following removal of tarry condensate in a knockout trap, the gases flow to a water scrubber where maleic acid is absorbed. Excess air is bled from the top of the water scrubber.

Scrubber bottoms flow to a dehydrator where maleic anhydride is generated from the acid. Careful selection and control of operating conditions in this step are used to minimize formation of isomeric fumaric acid.

Bottoms from the dehydrator flow to a rectification column via a surge tank. Product cut taken overhead from the column is cooled, pelletized, and bagged for shipment.

Plugging of the reactor product aftercooler with solid maleic anhydride is avoided by using tempered cooling water. Auxiliary equipment includes a startup heater, not shown on the flow diagram, to preheat the feed airstream to reaction temperature.

CHEMICAL REACTIONS:

Several oxidation reactions occur at the same time in the reactor. Most important of these are the oxidation of benzene to maleic anhydride and to carbon dioxide, shown below:

(1) $C_6H_6 + 4\frac{1}{2}O_2 \rightarrow C_4H_2O_3 + 2H_2O + 2\,CO_2$

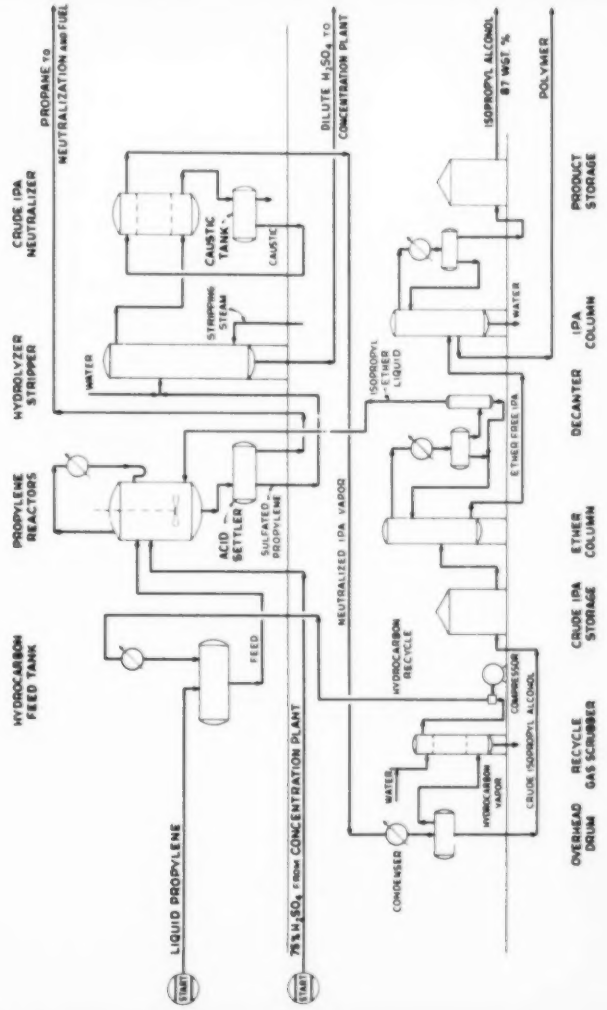
(2) $C_6H_6 + 7\frac{1}{2}O_2 \rightarrow 6\,CO_2 + 3\,H_2O$

COMMERCIAL YIELDS:

Overall yield, pounds of maleic anhydride per pound of benzene charge, of over 70 percent have been obtained. Future installations are expected to exceed 80 percent yield.

Isopropyl Alcohol Production

Licensed by: The Distillers Company Limited



Compare Your Operations With This Evaluation of

Equilibrium Fluid Cracking Catalyst

J. J. Blazek • F. H. Macke
Davison Chemical Company
Baltimore 3, Maryland

Reported are results of tests on 71 fluid units in the States and Canada

OFTEN, refiners will ask, "How do we compare with other refiners; are we high or low, and just what is high and low with respect to circulating catalyst activity and metals levels?" Of course, a definite answer to the latter question cannot be given, since every operation is peculiar to each refiner's particular situation. Economic justification must be determined for operating with a higher or lower circulating catalyst based on the particular circumstances. However, this program answers the first question, "How do we compare with other refineries?'

The best way of answering this question is by tabulating for each annual quarter the mean values and range of values for those properties which best define equilibrium catalyst quality for the entire U.S. and Canada. These data will be necessarily limited to those refineries which participate in the equilibrium catalyst testing program. However, the data should be representative of the U.S. and Canada, since participating units represent a large sampling of the total units in both countries.

In the table shown below, the mean and the range (defined by the 95 percent confidence limits) of catalyst quality for 71 units participating in the equilibrium catalyst testing program have been tabulated. Three periods are reported: The present quarter (February–April 1959), the previous quarter, and the year-ago quarter. Average value of each property for each participating unit was determined by averaging all relevant analyses obtained for that unit during the quarter under consideration.

Surface areas reported were obtained by the standard B.E.T. (Brunauer-Emmett-Teller) nitrogen adsorption method. Metal contaminants were measured by standard "wet" chemical procedures. The catalyst activity reported is by a variation of the D+L test of Standard Oil of New Jersey. It is basically the measure of the volume percent of liquid product boiling below 400 F obtained by cracking a standard East Texas gas oil over the catalyst being tested at standard operating conditions.

Range indicated for each catalyst property is necessarily broad, for it includes 95 percent of the participating units in the U.S. and Canada and thereby encompasses a great variety of gas oil feeds and localized operating requirements.

It is interesting to note that no appreciable change occurred in activity or surface area over the past year, nor is any seasonal operational change indicated between the present spring and previous winter quarters. Vanadium, nickel and copper contaminants have decreased slightly over the past year, but iron and sodium have increased.

Overall effect indicated by these changes is, perhaps, the combined effects of decreased fresh catalyst consumption (constant activity and higher iron and sodium levels) and improved cat cracking feed quality (lower vanadium, nickel and copper in the face of lowered fresh catalyst consumption).

In presenting these data, it is in no way implied that the mean values presented are the most desirable levels of operation. They are merely the levels at which the majority of the refiners participating in the catalyst testing program are operating. The wide range for each property tested is good evidence that all refiners cannot operate at the mean values.

On the other hand, these data should be a true reflection of changing trends in the operation of fluid units. Increased use of feed desulfurization and treating equipment, the use of coker gas oil as cat plant feed, changes in crude types, changes in fresh catalyst consumption, changes in fresh catalyst quality and changes in product demand are just a few of the complex variables whose net effect on catalytic cracking operations is indicated by a catalyst quality comparison of this type. ★ ★

Equilibrium Cracking Catalyst Quality.

PERIOD	PRESENT QUARTER FEB.–APRIL 1959		PREVIOUS QUARTER NOV. 1958–JAN. 1959		YEAR AGO FEB.–APRIL 1958	
	MEAN	RANGE*	MEAN	RANGE*	MEAN	RANGE*
ACTIVITY						
D+L	29.2	24.0–34.4	29.9	24.6–35.2	29.5	24.4–34.6
SURFACE AREA						
M^2/gm	117	71–163	119	70–167	115	70–160
METAL CONTAMINATION						
Vanadium, V: ppm	215	44–1053	196	43–919	259	43–1571
Nickel, Ni: ppm	83	15–453	71	12–434	107	20–585
Copper, Cu: ppm	4	.3–38	3	.3–36	5	.5–52
Sodium, Na: ppm	556	104–3079	527	74–3153	497	82–2968
Iron, Fe: wt.%	.37	.10–1.39	.33	.11–1.04	.32	.10–1.05

*95% of fluid units tested fall within these limits.

Editor's Note:
For nearly 10 years the Davison Chemical Company has been testing samples of equilibrium regenerated fluid cracking catalyst for petroleum refiners. Properties tested usually include a complete particle size analysis, surface area, average pore volume, complete chemical analysis and an evaluation of the catalyst's activity and selectivity. Units participating in this program have grown steadily, until at present catalyst from 71 fluid units located in the U.S. and Canada is being tested on a regular basis. This represents 48 percent of all fluid units currently operating in the U.S. and Canada.

All of these methods are fully described in a manual, "Methods of Analysis for Fluid Cracking Catalyst." Copies may be obtained by writing *Refining Engineer*.

DISTILLATION . . . in View of Modern Developments

— a series on recent developments in distillation and absorption techniques

Part II: DISTILLATION **Chapter 1 — Types of continuous distillation systems**

Conventional	***Vacuum Separations***	***Stripping***
Charge Reflux	***Steam Distillation***	***Absorption***
Charge Reboiler	***Multiple Tower***	***Crude Distillation***
High Pressure	***Steam Stilling***	***Extractive***
Low Pressure	***Low Temperature***	***Azetropic***

Kenneth F. Gordon •
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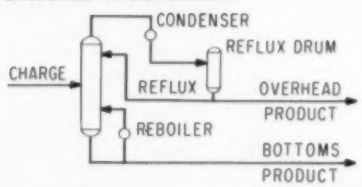
James A. Davies
Texaco, Inc. New York City

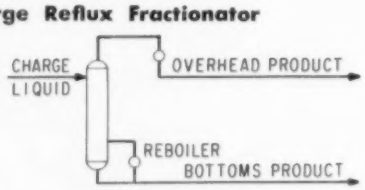
THERE ARE a host of different types of distillation systems all serving a particular need. The best one for a given case will be determined by the experience and ingenuity of the designer. Various distillation systems are outlined:

1. Conventional Fractionator



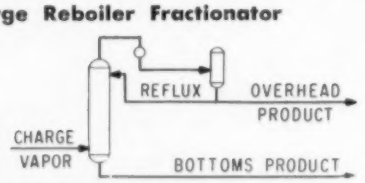
This system will give close separations for normal mixtures. The degree of separation will vary with the number of trays and reflux ratio.

2. Charge Reflux Fractionator



In this system there is no rectifying section nor reflux. The only variable of operation after the number of trays is fixed is the bottom temperature or quantity of heat input. Good bottoms purity can be obtained but at the expense of yield. If the overhead is small or can be recycled back, this system is attractive. An example is the side stripper on a side draw-off stream from a fractionator.

3. Charge Reboiler Fractionator



This is the complement of charge reflux tower and has only a rectifying section with the charge all vapor or nearly so. Here the only control of the overhead purity is the amount of reflux. Good purity of overhead is attainable but at the expense of yield. In essence, this is the type of tower that is used in crude distillation. It is also used to remove a very small amount of heavy ends in rerunning operations.

4. High Pressure

High pressures affect the design of the equipment, trays and efficiency. In a system in which the gas density approaches the liquid density, the equation used for tray design must be corrected for the gas density. Efficiency will be low because of high entrainment and a clear picture of the phase equilibrium must be available to insure the separation desired is possible. High pressures are used when it is desired to separate a material overhead with a high volatility and be able to condense it.

5. Low Pressure

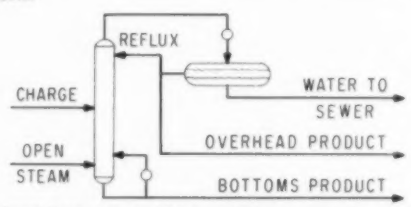
Except for the vacuum equipment this system is conventional. Usually fewer number of trays are required and the diameter is large. The trays must be designed for low-pressure drops. When pressures are below 5-10 mm of Hg the approach to equilibrium is slow and efficiencies drop off. Vacuum is used when temperature sensitive materials are to be separated.

6. Special Vacuum Separations

For pressures below 1 mm or for separation of high viscosity materials where approach to equilibrium is slow, special mechanical stills are resorted to. For very high vacuum molecular stills are used.[1] For high viscosity materials such devices as spinning disc and wiped surface evaporators are used. Rodney-Hunt makes a well-known one. Other vacuum stills have rotating concentric cylinders, brushes or discs.

7. Steam Distillation

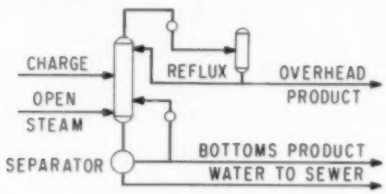
Another type of distillation that may be used for temperature sensitive materials instead of vacuum is steam distillation.



Any inert hot gas could be used but steam is usually used because of its availability and the immiscibility of water and hydrocarbon allows good separation in the liquid phase. The effect of the steam is to reduce the partial pressure of the material to be separated.

Sometimes open steam or water is introduced into the bottom of a fractionator operating under pressure in order

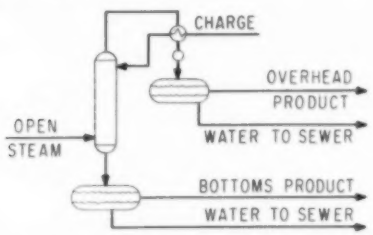
to decrease the bottom temperature to allow the reboiler to handle the necessary load by increasing its mean temperature difference.



Here the pressure is sufficiently high to condense the steam in the bottom section of the tower. This is only effective if the steam is immiscible with the bottoms products, or the bottoms are waste.

8. Steam Stilling

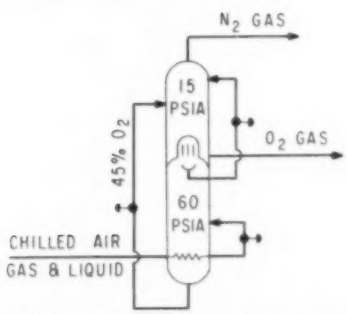
Up to a few years ago when oil refineries had a large amount of exhaust steam and processed considerable thermal cracked naphthas, a type of steam distillation was carried out called steam stilling. Thermal cracked naphthas were acid treated to remove objectionable components and this treatment raised the end-point temperature. The naphtha had to be rerun to bring the end-point down. This was done by steam stilling.



The open steam supplies all the heat required and is partially condensed. As seen the column operates as a charge reflux tower. This operation is successful because the bottoms have extremely high boiling point material.

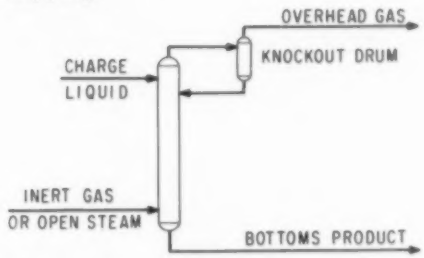
9. Low-Temperature Fractionation

Refrigerated fractionation is used to separate a system that otherwise would be impossible to distill because the critical points would be exceeded. Except for special cases like liquid air separation, low temperature fractionation does not require unusual design. There is the problem of design of the refrigeration system and heat exchange and the choice of construction materials.



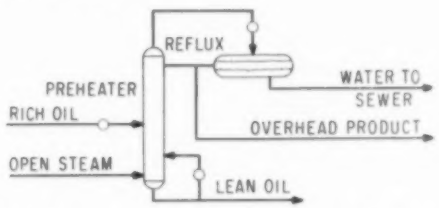
The sketch shows liquid air fractionation. The chilled air charge containing mainly vapor at a pressure higher than 60 psia exchanges its heat in the reboiler of the bottom or pressure tower and condenses and is charged to the lower tower. The bottom liquid contains about 45 percent oxygen in order to supply sufficient cooling load to the reboiler-condenser between the two towers. The nitrogen contained in this stream is flashed in the atmospheric tower thereby producing the required cooling load. The pressure of the lower tower is sufficiently high so that liquid oxygen at the bottom of the atmospheric tower will condense nitrogen at the top of the pressure tower. The liquid from the bottom of the pressure tower is charged to the atmospheric tower while the top of this tower is refluxed by the top liquid from the pressure tower. High purity gaseous nitrogen is produced overhead and gaseous or liquid oxygen from the bottom of the upper tower.

10. Stripping



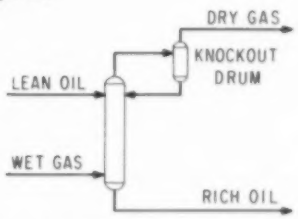
This is the usual stripping arrangement where small quantities of volatile material in the charge liquid are removed by an inert vapor.

Another type of stripper that removes absorbed material in absorber oil is shown.



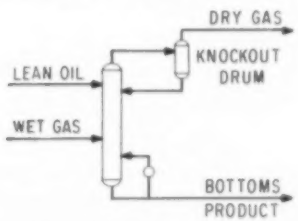
The bottom part of this tower is a stripper with a reboiler to assist in the stripping. The top section separates the absorber oil from the overhead product.

11. Absorption



The easily condensible material in a gas stream is absorbed in oil in an absorber. Intercoolers are used at times to increase the absorption. This process is not selective.

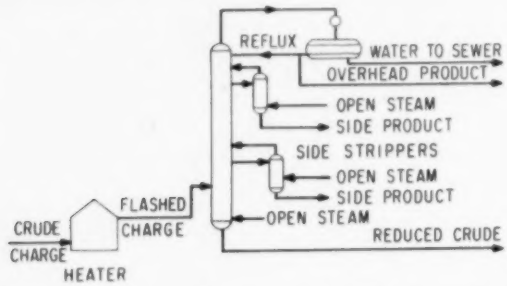
If the absorption is to be selective, a reboiler is added at the bottom. This system is called a rectifying absorber.



With this arrangement the heavier portions of the wet gas can be selectively absorbed without any of the lighter

portions. Frequently a rich oil instead of gas is charged to a rectifying absorber. Lean oil is used at the top of the tower to increase yield of the heavy gas components.

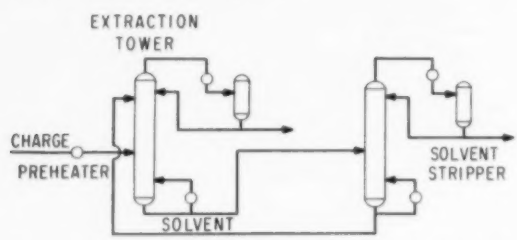
12. Crude Distillation



This is a specialized arrangement for the distillation of a complex mixture into multiple products. It is the most important distillation process in existence from the standpoint of investment. Practically all petroleum crude is initially processed with this system, both at or close to atmospheric pressure and under vacuum. Catalytic cracking effluent is processed similarly. Tower diameters range from a few feet in diameter to over 35 ft for a vacuum tower.

The section of the main tower above the feed is similar to a charge reboiler tower. The amount of charge vaporized in the heater approximates the overhead and side stream products. The section below the feed is a stripper for the bottoms product. Very little or no reflux enters this section from the section above the feed. The bottom stripping steam has a two-fold purpose; it is used to strip light components from the bottoms product and to reduce the heater outlet temperature to prevent thermal breakdown of the charge. At desired locations in the top section side streams are taken off. Since these streams contain components lighter than desired, they are sent to individual strippers for removal of light material.

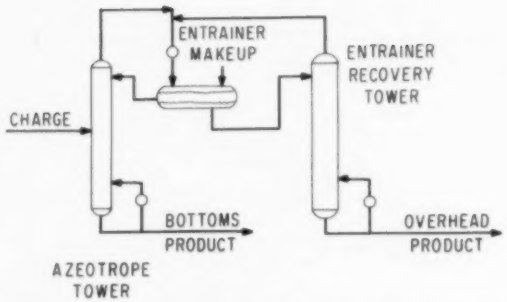
13. Extractive Distillation



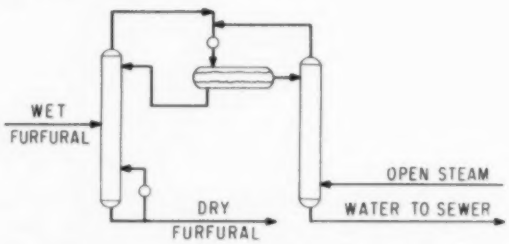
Certain solvents will affect the α, relative volatility, values so that separations difficult or impossible by ordinary distillation techniques can be accomplished. The first tower in the sketch is the extraction tower where the desired separation is made. The tower from the solvent feed point to the bottom can be thought of as a rectifying absorber. The charge comes in partly vaporized. The section above the solvent feed is an enriching section to prevent solvent from going overhead. The second tower, even though it is labeled a stripper, is a conventional fractionator to separate the absorbed material from the solvent.

14. Azeotropic Distillation

There are many varieties of azeotropic distillation systems. The sketch shows one of the simpler ones. The use of an entrainer component as reflux breaks the azeotrope in the charge and allows the entrainer to carry one of the desired cuts overhead. In this case the overhead condensate separates into two phases. The entrainer rich phase is used for reflux in order to maintain the necessary entrainer concentration on the top trays. The other phase is sent to the recovery tower where the entrainer is recovered as an overhead stream. In this case, the recovery tower is a charge reflux tower. Sometimes it is necessary to put the entrainer in the charge in order to be effective. The overhead may condense into a single phase. Also, the entrainer may appear in the bottoms as well and have to be recovered.

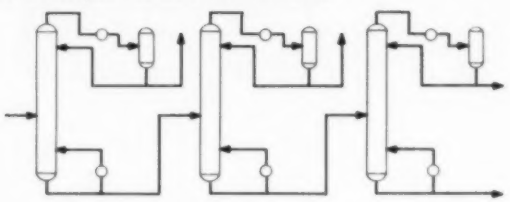


Some azeotropic systems can be separated by a two tower system without the use of an entrainer if the azeotrope vapors condense into two liquid phases with compositions on either side of the azeotrope composition. One such example is the elimination of water from furfural shown in the sketch.



The overhead in the first tower is the furfural-water azeotrope. The second tower overhead being a charge reflux tower is on the water rich side of the azeotrope.

15. Multiple Tower Distillation



The sketch shows a three tower system to separate the charge into four well fractionated products. This shows an arrangement frequently used with the lightest product coming off overhead from the first tower, the next lightest overhead from the second tower and so on. However, the most economical arrangement would have to be worked out for each case. In general, it is best to perform the easiest fractionation in the first tower where the charge rate is greatest and the harder fractionation on the smaller fractions. A convenient rule of thumb that helps decide this choice is that the reflux to charge ratio is constant for a given degree of separation between given components and is unaffected by changes in composition.[2]

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1. Hickman, K. C. D., *Ind. Eng. Chem.*, 39, 686 (1947).
2. Pierce, W. R., *Pet. Ref.*, 26, 92 (Sept. 1947).

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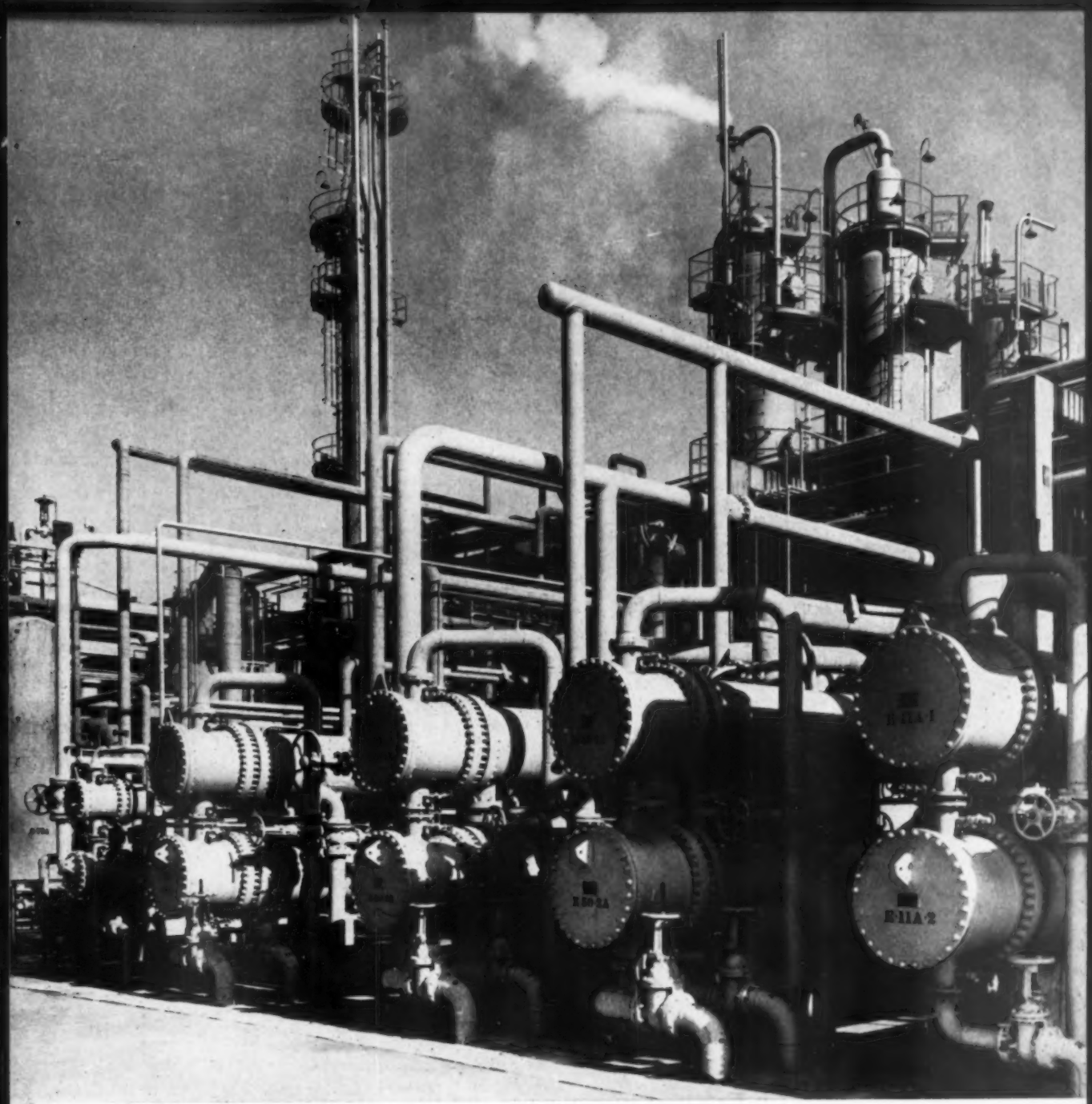

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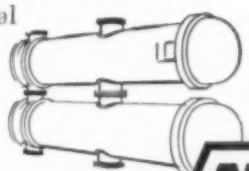

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REFINERY CONSTRUCTION MANUAL

PART 11: Pumps, Motors, Instruments

Henry Martyn Noel, *New Canaan, Connecticut*

Pumps

THE MODERN REFINERY is equipped almost exclusively with pumps of the centrifugal type. Thirty years ago the refinery pumps were almost all of the positive displacement type, usually duplex reciprocating piston pumps, steam driven. Older refineries therefore may contain both kinds of pumps plus certain others such as simplex plunger pumps, vertical triplex piston pumps, rotary gear pumps, etc. The centrifugal pump, sometimes with vertical shaft, has replaced other types due to its ease of control and its improved and simplified design with consequent greater economy in first cost and in operation. It may be driven by an electric motor or by a steam turbine. In either case it is apt to be direct-connected, eliminating a gear box, and its variation in output is regulated by throttling the discharge if motor driven or by speed change if turbine driven. Most large pump manufacturers purchase and supply the drivers to fit their pumps.

Pump manufacturers supplying the refineries are numerous. They are able to handle several times the normal demand from all industries. An important phase of their work for the refining industry is the manufacture of feed pumps for crude or cracking stock; these handle from 200 to 2000 gal per min at temperatures of up to 600 F and pressures up to 200 psig for crude stills or 1200 psig for reformers. They are of cast steel construction, using alloys where necessary against corrosion. Such units are vital elements of the process equipment and their design and construction is highly specialized. There is usually a spare pump provided for such important services although with expert pump maintenance men on the job these pumps often run continuously for a year. One outstanding modern feature of their design is the mechanical seal which prevents leakage around the high speed rotary shaft even at very high pressure.

Price for the feed pump for a large pipe still is about $5000, the motor costing the same or more; time for delivery after placement of order is 3 to 4 months (1958) for large or special pumps, 0 to 2 months for smaller pumps. Pumps for a modern refinery would number less than 100 in a simple case and only 200 for a large refinery without lubes.[21]

Steps in the manufacture of centrifugal pumps include preparation of shop drawings only for special units. The great bulk of a pump manufacturer's output consists of standard types for which drawings are already worked out and available to the shop. Material to be procured in filling a new order for pumps is apt to be simply for stock replenishment since most standard purchased parts and materials are kept in inventory. These purchased items include shafts, bearings, couplings, sleeves, gaskets and certain steel castings and forgings plus steel and alloy ingots.[22]

Operations in the large modern centrifugal pump factory itself include casting of casings and impellers, machining of all parts, heat treating, balancing, and assembling. Principal machines, tools and equipment for the pump factory are those of a foundry, a forge shop, and a large machine shop. The pump factory is particularly characterized by the special operations of impeller manufacture. The impeller must be machined to its final intricate shape, to very close tolerances, by highly experienced men. Personnel of a pump factory on the average is somewhat higher paid than ordinary machinists and blacksmiths.

In a large shop a schedule is made for each pump order, showing when all parts are to be made ready, allowing time for purchased items to arrive and allowing time for those made locally to be completed. Since every operation is standardized and men are paid for the standard number of man hours regardless of time actually consumed, cost can be accurately predicted. When all parts are ready and balanced, the assembling division puts the pump together and the testing department tests it under hydraulic pressure and for output performance. After this it is mounted, with or without its driver, and painted and shipped.

Making of parts includes castings and forging of items weighing anywhere from a few ounces to 25 tons. The foundry deals with all sorts of steel, alloys, aluminum and brass. Manufacture of shafts and sleeves and other small parts in a large pump factory requires about 200 machine tools and two acres of floor space. Casings are bored, milled, faced, etc., and impellers are specially machined. The testing division, with its electric and torsion dynamometers and its large tanks of water, requires almost as much space. In addition to the foundry, forge shop, machine shop, testing shop, heat treating department, tool department and store room, all indoors, there is usually a very large outdoor storage yard. Overhead and jib cranes and welding machines are in evidence in almost all departments.

Personnel of a large pump works comprises about 1300 men of whom 900 are on the first shift. Output of this plant is divided among power plants, paper mills, water and sewer works, oil and chemical companies, etc.[22]

Small standard pumps are often stocked in finished or nearly finished form whereas large standard pumps require work on connections, stuffing boxes, final machining and assembling. Labor in the shop runs from 100 to 1000 man hours for refinery pumps of 200 to 2000 gal per minute capacity, this exclusive of drivers.

Output from each of the major American centrifugal pump factories averages several thousand pumps per month,

predominantly of smaller sizes. Only about 12 percent of the output is for oil refineries. Total capacity in the country is such as to make it improbable that delivery of pumps would ever be the bottleneck in refinery construction. It is estimated that 50,000 centrifugal pumps of over 5 hp were produced by American factories in 1953.

Electrical

Electrical apparatus, consisting principally of motors, switch gear and starters, transformers, cables and fixtures, is an important category of refinery equipment. It is produced in the United States in many hundreds of factories, most of them specializing in a particular field but some covering all sorts of electrical equipment. Only the largest manufacturers produce refinery motors on a production line. The great majority of motors, except the small sizes, are not mass produced.

A medium size motor factory making motors mostly of 5 to 500 hp devotes nearly half its capacity to explosion-proof motors of sizes used by refineries. It fabricates motors complete, purchasing wire, ball bearings, sheet and shaft steel, impregnated cambric or glass fabric, cotton, lacquer, paint and cable. It is served by about 14 foundries which cast the cast iron parts from its patterns and it also purchases forged shaft stock for larger sizes.[28]

Laminations are stamped out of .019-in. silicon steel sheets containing 6 or 7 percent silicon. They are then slotted by another stamping operation. Laminations for the rotor are heat treated through a 24-hour cycle, going up to 1450 F for a brief period.

Castings are faced and bored and drilled. Shafts are rough turned from hot rolled stock and then finish turned. Ribs are welded on to the shafts except the largest sizes which have the ribs milled out of the shaft.

Both the rotor and stator laminations are ground after assembly to very close tolerances.

Wire is often purchased coated with an insulating film. It is purchased covered with cotton thread and is then twice dipped and coated with a polymerizing lacquer for insulation. Small wire and large rectangular wire, after coating, are fitted into the slots of the rotor and stator, being separated with coated cambric or glass fabric. Coils are connected with silver solder and cables are likewise attached with silver solder.

The rotor after assembling on its shaft is balanced on a special machine which rotates at only 300 rpm but which locates any imbalance.

The stator is mounted and connected and the whole motor is then assembled in the explosion-proof or drip-proof casing. These casings, usually of cast iron, are sometimes made of aluminum or even cast steel. They consist of the main body piece and the end pieces which are bolted on. All these pieces must be machined after they are received from the foundry. In explosion-proof motors there are air passages for the hole through which the cable passes. This hole is plugged around the cable with a special asphalt.

At a shop where there are hundreds of large size motors in production at the same time the labor force amounts to several hundred specialized craftsmen. Punching of the laminations, wrappings of the wire, fitting of the coils, lacquer dipping and insulating as well as balancing and testing of rotor wiring and of the final product are all jobs requiring special skills.

It is estimated that a 500 hp 1750 rpm motor for 2300 v, explosion-proof, costing the customer $17,500 (1959), would consume 2000 man hours in the shop.

Such a motor would require 16 to 20 weeks for delivery under 1959 conditions which are considerably better than in other recent years. It is possible that by diverting stock from other jobs and working two shifts on the winding, such a motor might be put out in an extreme emergency in 8 weeks. This would apply to only single isolated cases since emergency stocks could not be borrowed except in limited amounts after which the regular delays for receipt of materials would prevail.[28]

As regards switch gear and motor controls the same companies dominate. A representative plant produces metal enclosed units of switch gear for the 2300-v refinery motors and metal enclosed motor controls for the 440-v motors.

A plant would use 10-gage steel which it shears and punches and forms and welds to produce the metal cases for the units. A large special stamping machine with 16 tools is used to punch out the many special slots in the plates before they go to the large forming press for bending the lips. Steel cases, after fitting with shelves, brackets, etc., are sand blasted before painting. All equipment that goes inside of these units is procured from other plants except the heavy copper parts which are fabricated in the home plant. Other parts include contacts, insulators, solenoids, cables, signals, relays, oil pots, buttons, handles, etc.

Man hours per unit of such equipment which is expended at the factory shipping the final product are relatively few since they cover primarily an assembly job except for the steel cases. Number of man hours required for parts that go into the cases, in other electric factories, is considerably more important.

Transformers, oil immersed switches, conduits, fixtures and cable are all manufactured in special factories and in turn have their own suppliers of parts and materials. Ramifications of the supply system for electrical manufacturers extend into practically all other industries in the country, especially chemicals, fabrics, metals, oils and glass. In this respect shop fabrication of electrical equipment may be considered more complex than for any other refinery equipment. On the other hand, it is probable that the electrical industry by virtue of the wide diffusion of its supply pattern is the most flexible and best adapted to cope with sudden new demands.

In estimating the cost of a refinery, electrical equipment is included under several different heads such as process units, power distribution, water supply, etc. However, totaling items of electrical equipment for an entire refinery, it would be found that the amount would be in the neighborhood of 3 percent of the total refinery cost. This corresponds to from two to five man hours of work in the fabricating shops for electrical equipment alone, per barrel per day capacity of a simple fuels refinery.

Instruments

The modern refinery is not adaptable to manual operation, and control instruments are essential.

A typical small refinery incorporating cat cracking might contain about 200 control instruments centralized in two or three control panels, besides about 600 ordinary temperature and pressure indicators and recorders. There would be about 100 flow controllers, 40 level controllers, 40 temperature controllers and 20 pressure controllers. Total cost of this instrumentation, including control valves, leads and panels would amount to a minimum of $100,000, of which the vital control instruments would alone account for about $20,000.[11]

Suppliers of refinery instruments are not numerous but their combined manufacturing capacity is large. Their sales are divided among a large number of clients such as utilities, food, textile, metal, ceramic and chemical industries, so that refineries use only about 15 percent of the total instrument output.

There are 130 manufacturers of control instruments in the USA but the largest 22 take 60 percent of the business. Although many foreign concerns have attempted to produce control instruments, and branch factories for certain American instruments have been established in England and

Japan, the principal sources of thoroughly reliable refinery control instruments with reasonable delivery times, are in the United States and perhaps Germany.

Shop fabrication of control instruments is primarily a combination of small machine operations. Metal stamping, automatic screw machine work and precision assembling and testing characterize such shops. Designs of parts and sub-assemblies are well standardized and manual operations necessary for their production are minimized. Parts are stocked in large quantities and material supply is rarely a problem. In order to control output and to avoid unnecessary delays, delivery schedules are established by class of instrument resulting in a predetermined delivery time for each class excluding those regarded as special.[25]

Complete fabrication operation involves listing and ordering of component parts from outside sources and from the home shop, assembling, painting, calibrating and testing. At a typical large manufacturer's plant most parts are made in the home shop except for certain electronic parts and minor specialties. Principal purchases are small aluminum die castings, brass forgings, iron castings, metal tubing, rods, bars and sheets.

Due to the requirements of the users of electrical instruments, it is impossible to maintain stock instruments in quantity. Nearly every instrument is built to satisfy a specific customer requirement. All kinds of controls and actuating media are used in instruments, including air, fluid mercury, and electrical. A normal order to the production department may be for only 100 or 200 of a certain instrument or even for only 5 or 6. There is a department which actually produces custom-made instruments where specifications are so remote from standards that an engineer and machinist hand-tailor each job.

By having standard assemblies and sub-assemblies and detail parts in stock, rearrangements in a fixed pattern can satisfy most customer requirements. These combinations of sub-assemblies and detail parts can develop into millions of different models.

After an order containing the code description of an instrument has been received at the plant, it is transferred to an IBM punched card and these cards are used to determine, with IBM machines, parts requirements. There are batteries of these machines and operators constantly in use to keep a daily check on the stock situation. A six-weeks' stock of parts and materials is maintained so that as machines become available for new orders there is always a full supply of parts and materials to work with. There are nearly 500 people in the several acres of floor space devoted to these engineering, stock and scheduling departments.

There are in the neighborhood of 1000 machine tools on 10 acres of floor space at the plant and about 1600 operators. Operations include stamping, punching, drilling and milling of nickel, zinc or cadmium. Many other parts are made from purchased aluminum die castings or brass forgings by milling, boring, drilling and grinding.

Spot welding is done with two large machines and silver soldering is done with an induction heater. Steel flow meter mercury pots are welded by hand. Induction coils are accurately wound at the plant from coated and flattened wire, ranging from 42 to 22 gage, and are then impregnated with varnish under vacuum and pressure. Diaphragms of Teflon-coated glass fabric are made for certain flow meters.

Thermo-wells and drilled sockets are made in the shop on special equipment. Some of these wells are as long as 42 in.

Some of the machine tools at the plant have been especially developed for the precision work involved in fine instrument manufacture. Ordinary tolerances are plus or minus two thousandths of an inch but some parts are ground or milled much closer. Zinc and nickel plating is applied .0002 in. thick and the cadmium .0004 in.

Steel cases and parts for instruments are "bonderized" before painting, that is these parts are chemically treated in a series of vats to prepare the surface against future oxidation. They are then spray-coated with enamel and baked.

All instruments have to be calibrated, pressure tested, operation tested and finally inspected. There are racks containing hundreds of instruments under inspection at the plant and it is noteworthy that so few of these instruments are duplicates.

The instrument industry, while it can be considered self contained to a certain extent, must of necessity depend upon supplies from the electrical component manufacturers, the foundry and forging industries and producers of raw materials for components and raw materials required in the manufacture of the completed product. Production of these supplies is of the intermittent type and requires maintenance at the plant of approximately 24,000 perpetual inventory records of parts. Included in these records are approximately 3200 purchased items covering component parts, foundry products and raw materials. Actual man hours for the fabrication of most control instruments are relatively few; approximately 15 to 20 hours of machining, 15 to 20 hours of assembling, and 15 to 20 hours of indirect labor, such as inspection, testing, stock room work, etc. The most complicated electronic control instrument requires a total of 70 to 80 fabrication hours. Availability of the small machine tools, dies, molds and fixtures limits shop output.[25]

Due to the small number of specialist manufacturers, it can be seen that a sudden flow of orders could easily result in long delivery times. Present delivery time (period from receipt of order to shipment from factory) for flow and pressure controllers is about three months. For temperature controllers this time is about four and one-half months. Liquid level controllers can be obtained in two months.

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DU PONT *Petroleum Chemicals* NEWS

Number 97 in a Series of Bulletins for the Petroleum Industry

JULY-AUGUST 1959

TEL overseas

How DuPont services the oil refineries of the world

Key Men In DuPont Export

WALTER MEES: For the past nine years, Walter Mees, at the left, export manager, has traveled up to 100,000 miles a year helping refiners all over the globe to use DuPont TEL and other additives efficiently. Holland-born and a graduate of a commercial and technical college in that country, he speaks five languages fluently and understands two more.

Before joining DuPont in 1950, Mr. Mees had 12 years' experience with the Royal Dutch Shell group, ranging from drilling to marketing to a management position in Venezuela.

With his broad experience as a producer and marketer of petroleum products, plus his intimate knowledge of world-wide oil operations, Mr. Mees has become well-known for his success in offering DuPont's extensive services and resources to help solve the problems of oil men on all continents.

RENATO S. CARDOSO, above right, as an export account manager, handles much of the world-wide contact work of the Petroleum Chemicals Division.

Brazilian-born Mr. Cardoso studied in schools in Spain and Portugal before entering Columbia University in New York. He then transferred to the University of Pennsylvania to study chemistry.

He joined the Export Division of DuPont in 1936, after working for a year at the General Chemical Company. During World War II he served with the Army Chemical Corps and returned to DuPont in 1946. He was as-

CONTINUED OTHER SIDE

34,000-LB. CONTAINERS like these travel overseas. The one shown here is destined for Puerto Rico. All DuPont TEL sold overseas is made in the United States but not all ports can receive the containers shown, and drums are used in their place.

DuPont tetraethyl lead shipments are a familiar sight at Manaus, location of an oil refinery 1000 miles up the Amazon River . . . at Iquitos behind the Peruvian Andes . . . in all of Japan's refineries . . . and at dozens of other refineries throughout the world.

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Besides all this, there's routine servicing concerned with supplying basic technical literature and films and sales promotional material. Also, supervising the unloading of TEL and keeping it under close observation from manufacturing plant to blending plant. We furthermore take part in industry public relations and we cooperate with foreign governments insofar as public health is concerned.

If you'd like to know more about just what services are available and how they are obtained, please address Mr. Walter Mees, Export Sales Manager, DuPont Petroleum Chemicals Division, Wilmington 98, Delaware.

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OVER

DUPONT *Petroleum Chemicals* NEWS

CONTINUED **Key Men**

signed to the Petroleum Chemicals Division at the beginning of this year. Mr. Cardoso speaks four languages.

Diesel fuels with FOA-2 and DMD stay stable, show no sludge

Small quantities of DuPont Fuel Oil Additive No. 2 and Metal Deactivator can keep a diesel locomotive's injectors sliding free and its filters unplugged even when a blend of economy grade oils is used for fuel.

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In a second test in the same area, just half the amount of additive solved a problem of filter clogging and injector sticking in truck engines.

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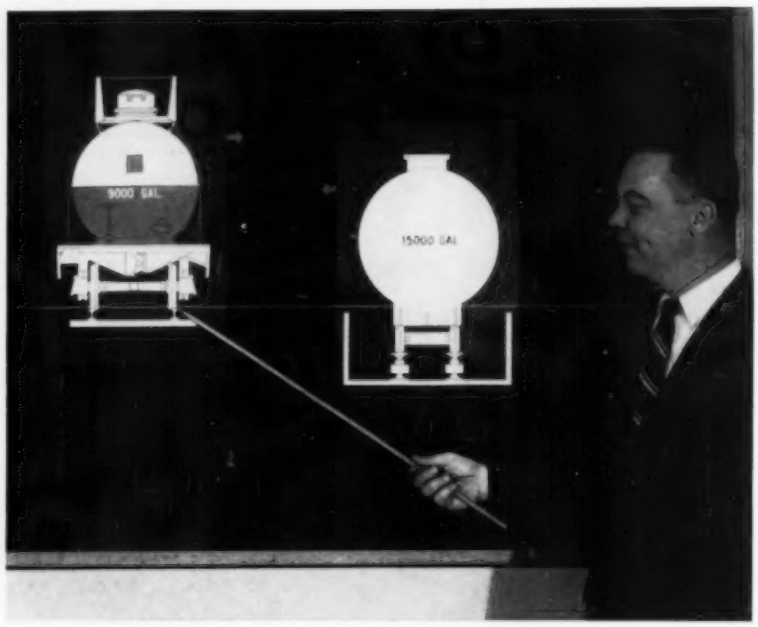
Your DuPont representative – his office is listed below, right – can fill you in on the details of both these DuPont additives. They are sold overseas as well as in the U.S.A.

Neoprene-modified asphalt roads show great promise in tests

Twelve different states are currently helping in tests involving roads laid with asphalt modified with DuPont neoprene synthetic rubber.

The new combination appears to do a better job of holding cover stone in place and preventing weather from breaking through to the roads' bases.



New flannel board gives cues on TEL tank car unloading

To help you evaluate TEL unloading procedures for optimum efficiency, DuPont has prepared a flannel board presentation which can simulate exactly actual plant conditions.

With the kit provided you can duplicate tank car size, size of weigh tank, and unloading line elevation in exact scale.

Calibrated cards show lift in inches Hg, vacuum needed for lift, and vacuum needed to start flow when you must overcome liquid pressure in the tank.

A slide rule shows quickly the rate of flow you can expect with a system, allowing for the variables of height, pipe friction, and pumping force.

If you're looking for a way to present such facts concisely and graphically to a group, contact the DuPont representative nearest you. His office is listed in the box below.

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OVER

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A-11370

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Where do you fit

in the changing petroleum picture?

records show that 294 refiners have tripled average production—but 160 have succumbed to competition

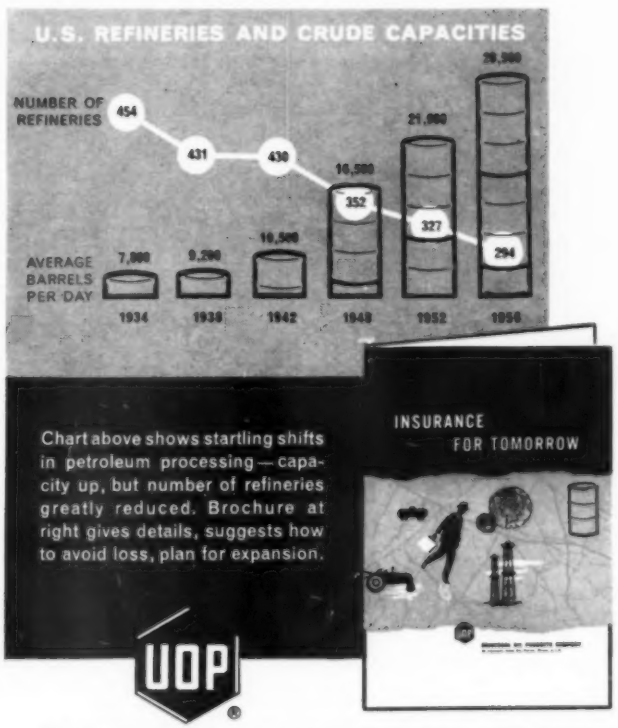

Chart above shows startling shifts in petroleum processing—capacity up, but number of refineries greatly reduced. Brochure at right gives details, suggests how to avoid loss, plan for expansion.

Drastic changes in transportation by road, rail, water and air constantly keep petroleum refiners on their toes. Adding to the complexity of the petroleum refiner's problem are never-ceasing changes in the nature and location of his crude supplies, and of markets for his products.

In this situation there are certain things the refiner can do to avoid losses and capitalize existing opportunities—to utilize his facilities and market potentials to the fullest.

As an aid to intelligent planning, the Economic & Market Research Department of Universal has prepared a bulletin entitled, "Insurance for Tomorrow." It shows how Universal can help coordinate the application of processes to achieve the most economic operation. Send for your copy today. Just fill out and mail the coupon.

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Method for Calculating Octane Ratings of Gasoline Blends

George E. Mapstone, *SATMAR, Boksburg North, South Africa*

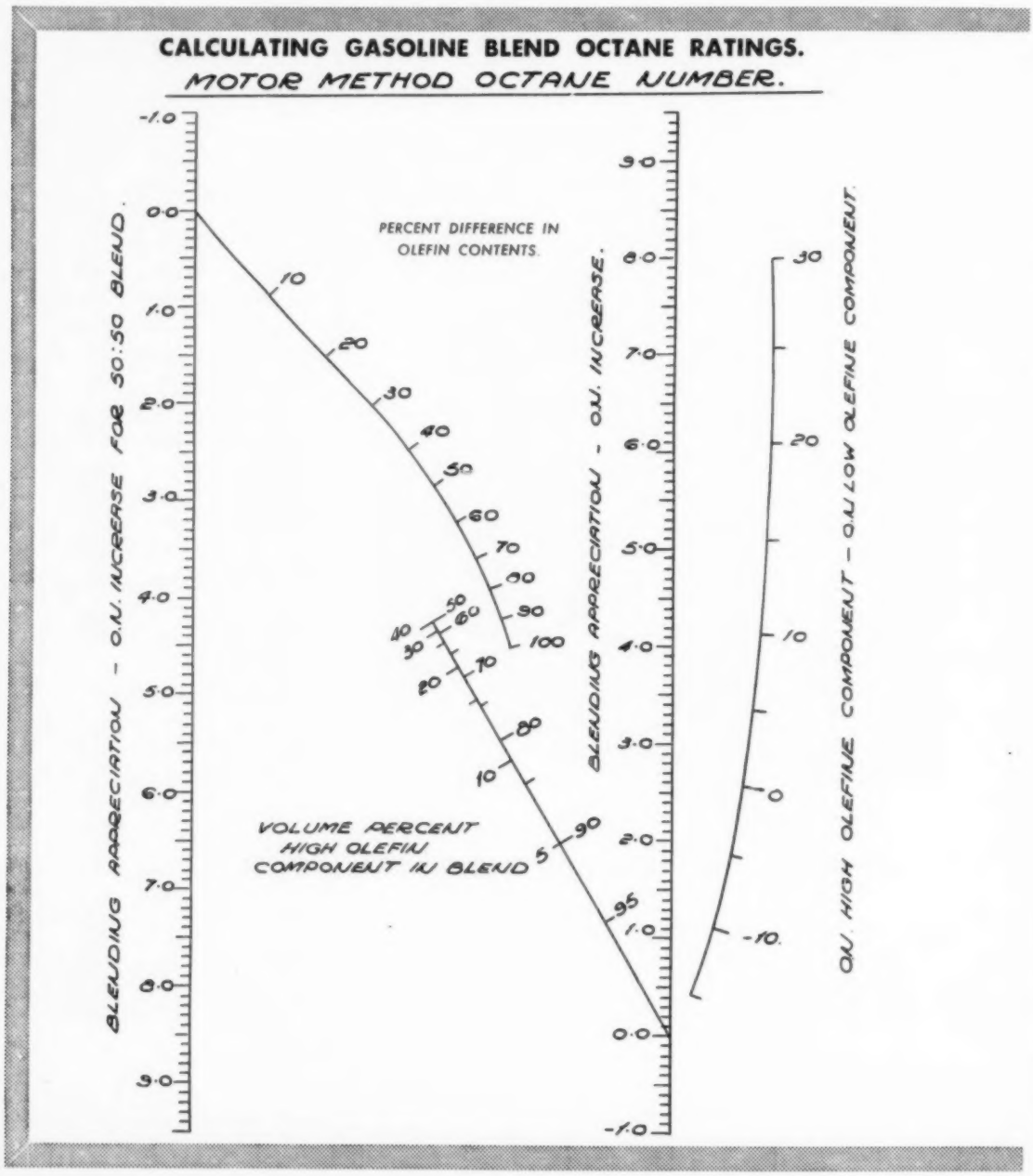
THE OCTANE RATING of a gasoline-blend is frequently higher than the simple arithmetic average of the blend component octanes. Schoen and Mrstik[1] have shown that this appreciation is a function of the differences in the olefin contents and octane ratings of the blend components, and of their proportions in the final blends. The appreciation is somewhat different for Research and for Motor Methods although the effects are similar for both methods.

Ternary or more complex blends can be calculated readily by treatment as a sequence of two-component blends; e.g. a blend of components A, B, and C is treated initially as a blend of components A and B to give component D, the final blend being one of components C and D.

The nomographs presented here allow the ready calculation of the blending appreciation of binary blends of components of known olefin contents and octane numbers. The method of using the charts is as follows:

By means of a straight edge join the point on the right hand curved

[1]Schoen, W. F. and Mrstik, A. V., Ind. Eng. Chem., 47; 1740-2 (1955).


CALCULATING GASOLINE BLEND OCTANE RATINGS.
MOTOR METHOD OCTANE NUMBER.
BLENDING APPRECIATION - O.N. INCREASE FOR 50:50 BLEND.
PERCENT DIFFERENCE IN OLEFIN CONTENTS.
VOLUME PERCENT HIGH OLEFIN COMPONENT IN BLEND
BLENDING APPRECIATION - O.N. INCREASE.
O.N. HIGH OLEFINE COMPONENT - O.N. LOW OLEFINE COMPONENT.

scale for the difference between the octane numbers of the two blend components with the point for the difference between the two olefin contents on the upper central curved scale, and extend to the left hand scale to give the blending appreciation for a 50:50 blend. If the blend required is a 50:50 blend this is as far as it is necessary to go. However, if the components are blended in some other proportion this value is then connected with volume percent of high olefin component in the blend (lower diagonal scale) and extended to give the blending appreciation on the right hand vertical scale. This value is then added to the octane rating calculated for the blend on the assumption of a linear relationship. The method of calculation is best illustrated by means of an example, thus:

What is the octane rating of the following blend?

Component	A	B
Volume percent in blend	30	70
Olefin content percent	10	70
Octane number (Res.)	60	85

Step I. The octane number of the high olefin component minus the octane number of the low olefin component is $85 - 60 = 25$.

Step II. The difference in olefin contents is $70 - 10 = 60$ percent.

Step III. From these figures the chart gives the blending appreciation for a 50:50 blend as 3.6 numbers.

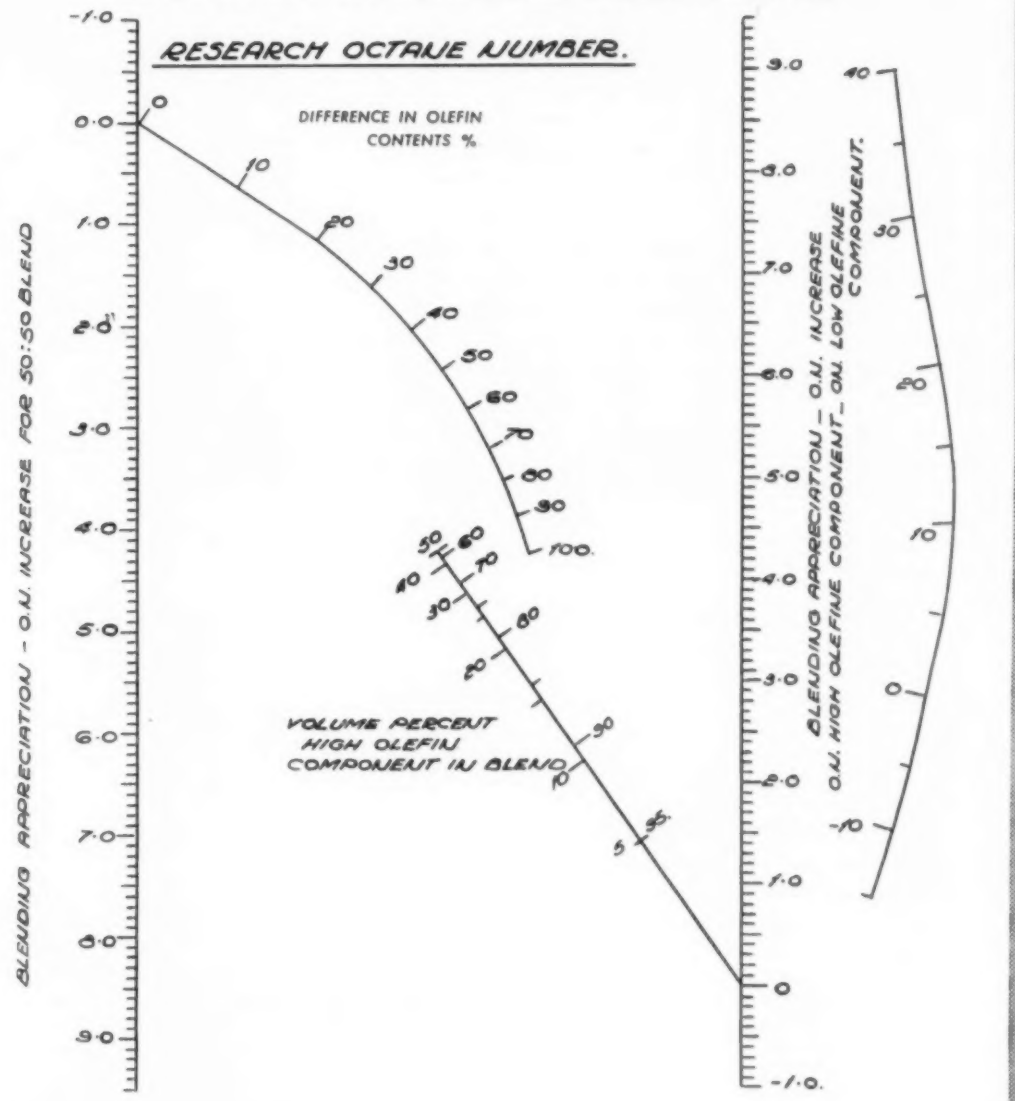
Step IV. Using the chart again gives the blending appreciation for a blend containing 70 percent of the high olefin blend as 3.2 numbers.

Step V. Assuming linear blending the octane rating of the blend would be $0.30 \times 60 + 0.70 \times 85 = 18.0 + 59.5 = 77.5$.

Step VI. Adding the blending appreciation from step IV to the calculated value from step V gives the octane rating of the blend as $77.5 + 3.2 = 80.7$.

* * *

CALCULATING GASOLINE BLEND OCTANE RATINGS.


RESEARCH OCTANE NUMBER.
DIFFERENCE IN OLEFIN CONTENTS %
VOLUME PERCENT HIGH OLEFIN COMPONENT IN BLEND
BLENDING APPRECIATION - O.N. INCREASE FOR 50:50 BLEND
BLENDING APPRECIATION - O.N. INCREASE O.N. HIGH OLEFINE COMPONENT - O.N. LOW OLEFINE COMPONENT.

HIGHLIGHTS OF
in the electric

PETRECO®

A long list of "firsts" has been added to Petreco achievements since the first electric demulsifying plant was installed for the Lucille Oil Company at Coalinga, California in 1909.

By continuing to carry on a program of progressive development, Petreco has been able to keep pace with the growing needs of the petroleum industry. The electric demulsifier came at a time when the problem of emulsion threatened to cause the waste of millions of barrels of "cut" oil. Then, when salt was recognized as a prime enemy of the refinery, the first electric desalter was developed by Petreco. Petreco was on hand, too, to answer the call for a method of removing sediment from certain crudes when they were found to be shortening the life of sub-surface pumping equipment.

Petreco has also helped in many important ways toward making refinery processing a more exacting science. Petreco electric distillate treating has brought automatic, precision-controlled accuracy to such operations as contacting, scrubbing and washing.

A single-purposed dedication to pioneership in its field, has enabled Petreco to grow by helping the various branches of its industry to better methods, better products and greater operating efficiency . . . with substantial profits as a result. Petreco shall continue to devote its total energies and experience to this program.

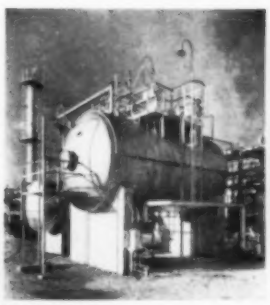
In 1906, Dr. Frederick G. Cottrell of the University of California, perfected a method of precipitating solids from flue gases by subjecting the latter to the forces of a 100,000 volt electric field. In exploring possible uses for the process his attention was called to the tremendous waste in the petroleum industry caused by "useless" oil held in emulsion.

After a series of extensive tests into the use of the electric field for breaking emulsions, the first commercial installation was set up at the Lucille Oil Co., at Coalinga, California. The plant successfully reduced an emulsion of 14% water to less than 2% at the rate of 1000 barrels a day. The first electric dehydrator had been installed, and Petreco had taken the initial step in leadership based on a long series of "Firsts".

50 YEARS' LEADERSHIP

processing of petroleum products

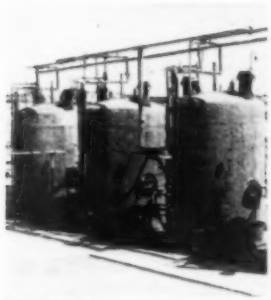
FIRST* *Closed Dehydrator*



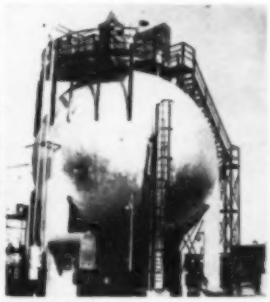
FIRST *Horizontal Electric Treating Unit*

FIRST *Pressurized Dehydrator*

FIRST *Flow Line Dehydrator*



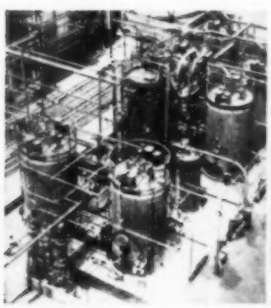
FIRST *Electric Desalter*



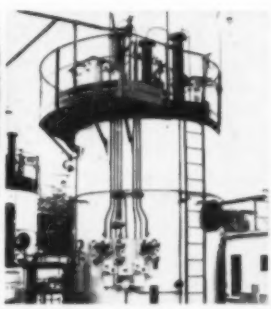
FIRST *Spherical Desalter*

FIRST *Electric Distillate Treater*

*Photos used are typical of types of units mentioned. They are not, in every instance, photos of original installations.



FIRST *Electric Desaponifier*



FIRST *Electric Lube Oil Treater*

FIRST *Electric Sediment Separator*

FIRST *Two-stage Electric Distillate Treater*

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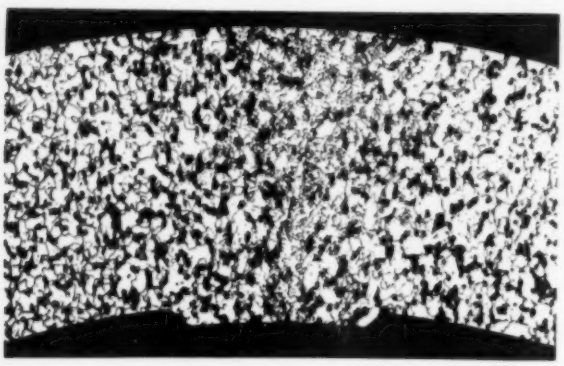
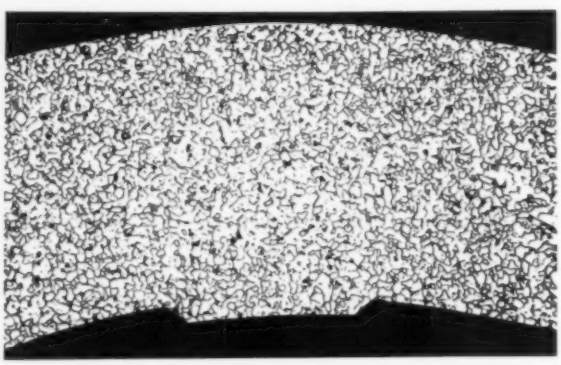
10-32 Percent Savings With . . . Welded Tubing





Milk isn't the only thing homogenized today — steel is now homogenized, with better tubing for heat exchangers as the result. Photomicrographs show before-and-after views of the steel grain structure of a new line of **"Lectrosonic"** tubing. At left, grain structure where edges of flat metal strip have been joined by electric resistance welding varies distinctly from rest of tube. At right, heat treatment (normalizing) has homogenized all the steel, making it **uniform** in appearance and **strength.**

Key to the new tubing is a unique quality control system closely integrated with the fabrication process. Vital phase of the process is the use of newly developed ultrasonic testing devices to provide a continuous and automatic check of the weld as it is made.

Automatic removal of weld flash from the entire length of tube during fabrication improves corrosion resistance and flow properties, and also permits alteration of tube length in the field.

Tubes are produced in complete range of sizes through 4½ in. OD and in all normally required standard wall thicknesses. They meet ASTM Specifications A-214 and A-334 Grade C and identical ASME Specifications. Their proved performance covers use in heat exchangers and condensers for the chemical and refrigeration industries. They are operating in service in boilers at pressures as high as 2700 psi. Prices show saving from 10 to 32 percent over comparable grades of seamless tubing. *The Babcock & Wilcox Company.*

Circle number (41) on reply card.

Fire-Resistant Hydraulic Fluid

Water-in-oil emulsion type hydraulic fluid possesses, in addition to its fire-resistant properties, a very high viscosity index (130) with film strength at high temperatures, thermal stability even when subjected to operating temperatures of 150 F for prolonged periods and anti-wear and anti-rust characteristics. *Sun Oil Company.*

Circle number (42) on reply card.

Iron-Like Adhesive

A wonder iron-like adhesive and sealer that can be used to repair everything from a broken chair leg to a cracked engine block, according to the manufacturer, will be available in late summer. The putty-like synthetic plastic sets up into a substance like iron a few hours after it is mixed with a clear liquid hardener. Retains strength under heat up to 300 F and cold down to 0. *Cycleweld Chemical Products Division, Chrysler Corporation.*

Circle number (43) on reply card.

Permanent Anti-Freeze

Fina permanent anti-freeze is an all-winter, glycol-base product which is reported to provide safe, sure protection against freezing, prevent rust and corrosion, and will not foam, evaporate or clog cooling systems. *American Petrofina, Inc.*

Circle number (44) on reply card.

USAF Information Machine

Result of a 2-year development program by United States Air Force scientists is the Print Reader, an information machine which reads typewritten pages and translates them into electrical signals at the rate of 200 characters per second. *Intelligent Machines Research Division, Farrington Manufacturing Company.*

Circle number (45) on reply card.

Multi-Block Heater

Second series of tube heaters has been manufactured for close control of temperatures in extractions, digestions and other types of reactions performed in test tubes and other small vessels. Heat transfer blocks which sit in the well-insulated shell of the heating base are readily interchangeable. Temperature range is ambient to 300 C. Their compact size makes them easily portable. *Research Specialties Company.*

Circle number (46) on reply card.

Wall Conversion Chart

A reference table for engineers and other executives speeds up the location of factors used daily. Included are common conversions such as inches to centimeters or watts to hp. New edition has been published by *Precision Equipment Company.*

Circle number (47) on reply card.

Flexitrays

In 1957-58, fabrication of Flexitrays exceeded that of the nation's entire bell cap production. Success of these low-cost devices for distillation, absorption and stripping is primarily due to their extreme flexibility and high capacity. Their use makes possible the design and construction of smaller, lighter-weight towers that have often saved plants 20 to 40 percent in total cost of complete tower installations.

Contacting pattern of the Flexitray is similar to that of the bell cap, except that no false means is present to direct effluent vapors vertically after passing through tray slots. Horizontally directed slot energy is dissipated below the liquid in the contacting mass. Entire tray area is available for liquid-vapor breakout. Vapor separates at lower velocities, and, since no obstruction to liquid flow exists, there is no liquid gradient.

Maintenance has been less expensive since the tray is more streamlined. No stagnant areas are present in which foreign material can collect. In many installations where bell cap trays have been replaced with Flexitrays, cleaning cycles have been lengthened as much as 750 percent. In butane separation, where sharp separations are common problems, Flexitrays have proved to be especially advantageous. *Koch Engineering Company.*

Circle number (48) on reply card.

Recording Controller

Two space-saving models of the Speedomax H recording controller for steam temperature control are offered. Both models are only 12 in. high and 11 in. wide, yet offer easy readability. Model S strip chart is best for detailed records while Model R is recommended for bold indication. With its range of 500 to 1200 F, the instrument has an accuracy of more than ±0.3 percent, while sensitivity is better than ±0.1 percent. *Leeds & Northrup Company.*

Circle number (49) on reply card.

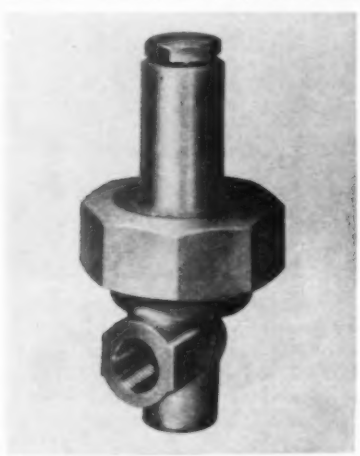
Exhaust Snubbers

Burgess-Manning snubbers eliminate excessive exhaust noise from 12 550-hp engine compressors at Continental Oil Company's West Short Junction plant, resulting in the comparatively quiet operation of the plant. Snubbers can be used to reduce exhaust or intake noise of internal combustion engines, compressors and similar equipment, and to eliminate dangerous pulsation in closed pipeline systems. *Industrial Silencer Division, Burgess-Manning Company.*

Circle number (50) on reply card.

PVC Relief Valves

These inexpensive, newly-developed polyvinyl chloride (PVC) relief and back pressure valve protect positive displacement pumps metering such process liquids as dilute sulfuric acid, hydrofluosilicic



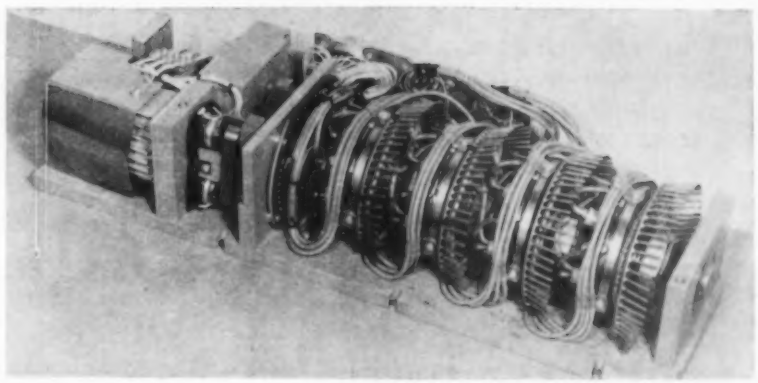
acid and hypochlorite solutions from excess pressures. Manufactured in ¼-in. and ½-in. sizes, the relief valve can withstand pressures to 400 psi at 68 F and to 200 psi at 140 F. Back pressure valve is manufactured in the same sizes and can withstand pressures to 200 psi at 140 F. *Milton Roy Company.*

Circle number (51) on reply card.

Beveled Orifice Unions

Orifice unions perform metering, measuring and flow control in industries utilizing pipeline networks to transport liquids or gases at high or low temperatures. A new beveled orifice plate for the new unions has been designed which has a stainless steel plate shaped to fit the contour of the union seat and eliminates gaskets. Available in sizes from ¼-in. through 2-in. pipe sizes. Working pressures range from 3000 lb at 100 F to 925 lb at 900 F. *Clayton Mark and Company.*

Circle number (52) on reply card.



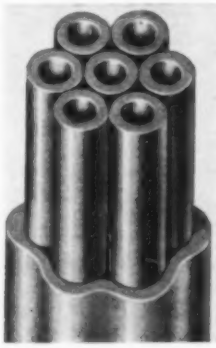
Pressure Scanner

Up to 160 individual pressures can be read with only 16 transducers with a new pressure scanner which saves not only the cost of transducers but considerable time in calibration. Made of stainless steel and anodized aluminum, instrument is 20 in. long, 6 in. wide and 4 in. high, and thus can be mounted easily in the "sting" of a wind tunnel. *Datex Corporation.*

Circle number (53) on reply card.

Polyethylene Tubes

Tubing bundles of multiple polyethylene tubes in a vinyl sheath are available in lengths up to 1000 ft. Called "Instrutube," the tubes are made from virgin polyethylene of high molecular wt and low melt index. Said to have excellent aging properties, good low temperature toughness and superior resistance to environmental



applications. *Pyramid Plastics, Inc.*

Circle number (54) on reply card.

Pushbutton Plotter

A pushbutton-operated plotter incorporates such features as vernier scale ranges, high accuracy and ease of operations. Flat vacuum platen and provision for precision positioning facilitates paper alignment and loading. Features a static

accuracy of ± .1 percent of full scale and a dynamic accuracy of ± .2 percent of full scale at 10 in. per second tracing speed. *Librascope, Inc., a subsidiary of General Precision Equipment Corporation.*

Circle number (55) on reply card.

Chem-O-Feeder

Electrically driven, positive displacement chemical proportioning pump features a corrosion-resistant transparent plastic head, Hypalon diaphragm and

check valves, and a straight-through flow design. It is available in 3 models for adjustable, wide-range proportioning up to 12, 24, and 36 gal per hr with discharge pressures up to 125 psi. Complete package ready for installation includes Chem-O-Feeder, suction and discharge tubing, injection nozzle, foot valve, tools and spare parts and a complete instruction booklet. *B-I-F Industries, Inc.*

Circle number (56) on reply card.

Vertical Turbine Pumps

Ultra High Flow (UHF) Pump offers broader coverage to the customer who can select a custom-made pump from a standard group of alternates. It ranks about 4 percent above Worthington's previous efficiency standards, and maintains high efficiencies over wider operating ranges, assuring continual and efficient service under any accidental conditions. By increasing the range over which it operates efficiently, pump also secures a reduction in power costs. *Worthington Corporation.*

Circle number (57) on reply card.

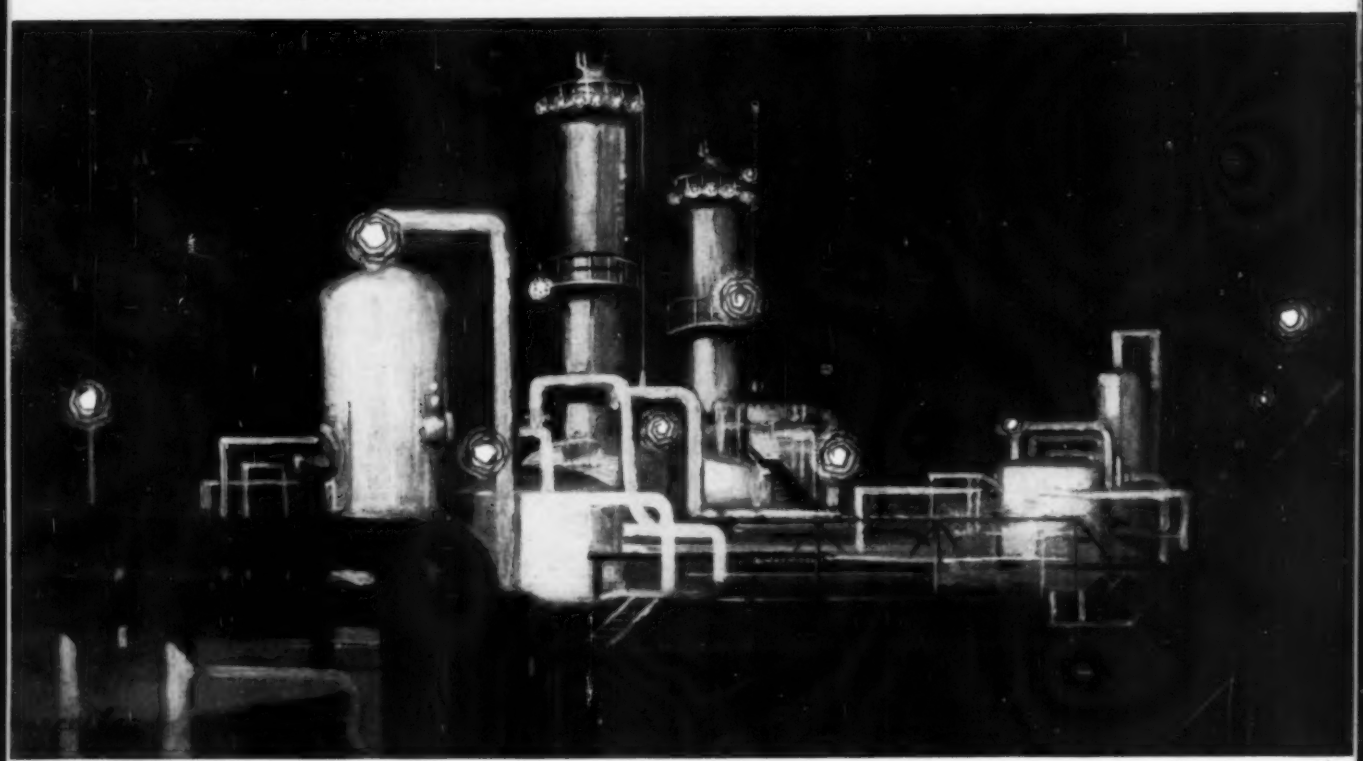
Highlights of Computer

Six-page illustrated bulletin describes highlights of the Bendix G-15 digital computer with emphasis on the magazine-loaded photo tape reader offered as standard equipment. *Bendix Computer Division, Bendix Aviation Corporation.*

Circle number (58) on reply card.

A refinery never sleeps

Twenty-four hours a day, a refinery is in operation. Its hundreds of miles of tubular products are constantly subjected to high temperatures and tremendous pressures. In order to survive under conditions like these, the tube must be hand-picked for the job. And, that's where National Tube comes in. If you need advice in refinery tube selections, get in touch with National Tube.



Our experience in this field comes from more than 60 years of gathering information for the solution of refinery tube problems. And, we've used this data to develop 24 different seamless steel tube analyses—each one the answer to a specific set of refinery conditions. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are under study.

National Tube's Mill Service Force, available for field consultation, will be happy to help you find the right alloy, at the right price, to meet your needs. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

Here are National Tube's two dozen different tube analyses:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2¼ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni

"The world's largest and most experienced manufacturer of tubular products"

USS National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division - United States Steel Export Company, New York

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Electronic Computer Holiday

TALK ABOUT A "BUSMAN'S HOLIDAY" . . . the four high school students and one instructor pictured above are "enjoying" their summer vacation at the Computer Center on the campus of Oklahoma State University.

In conjunction with the National Science Foundation, Oklahoma State University is carrying on a High School Participation Program designed to acquaint outstanding high school students with methods used in scientific research; current research in their major field of interest; and with engineers and scientists actually engaged in research work.

Candidates selected are shown observing operation of the IBM 650 computer. They are, left to right:

Doyle (Eddie) Morrison Jr., a graduate of Fayetteville High School, Fayetteville, Arkansas, is working with the Fenske Equation for estimating the minimum number of trays. Accuracy of the technique depends upon the average value of alpha (α) used. A modified procedure, wherein "K" values rather than alphas are used to estimate volatility was recently published. Eddie is using the computer in comparing the minimum number of trays by each technique.

John Welge is a senior at Thomas A. Edison High School in Tulsa, Oklahoma. John's project is directed toward a modification of the Ponchon-Savarit binary method of calculation so that it may be used with multicomponent systems.

Richard M. Lotspeich (seated at console) is a high school mathematics teacher holding a Master of Science Degree in mathematics. He plans to continue toward a Doctor's Degree. He is participating in the program on a slightly different basis but with the same general aims and purposes. Mr. Lotspeich is programming the Weymouth formula for natural gas line flow.

Martha L. Stocking is a senior at Stillwater High School in Stillwater, Oklahoma. Her problem is the study of the effects of the equilibrium constant and enthalpy on distillation separations. Results of this computer work will help point up the need for more complete thermodynamic property data.

Gerald Wright just completed his junior year at Wagoner Senior High School in Wagoner, Oklahoma. Gerald is studying the effect of combining a feed vapor at its dew point with the dew point vapor off the tray below, which is also at its dew point, when the temperatures of the two streams differ.

According to **Dr. R. N. Maddox,** "What we have tried to do is to assign research projects that would be equivalent to those carried out by a candidate for the Master's Degree in Chemical Engineering." Dr. Maddox, advisor to the group during their summer activities, is head of the School of Chemical Engineering at Oklahoma State University and is a well-known consultant in the petroleum industry on distillation problems and computer programming.

Ideco's portable H-40 Dual Rambler drilling rigs are credited with reducing the well completion time for Y.P.F. Argentina from 45 days to an average of 15 days. Yes, these dual trailer units really save time, and they withstand years of rugged field service. One example of the special features which assure long-life service from Ideco rigs is protection from corrosion.

The ten H-40's shipped from the U.S.A. to Y.P.F. were given the best corrosion prevention treatment available. Each unit was completely zinc coated, by hot-dip galvanizing or metallizing, at the Nowery J. Smith Co. Large structural parts not suitable for hot-dip galvanizing, because of size or dimensional stability requirements, were protected with special metal spray treatments by competent craftsmen. This extra protection means that Y.P.F. will get better than good service from its Ideco rigs for many years without fear of breakdown due to corrosion.

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Refining Literature

Crystal Structure Report

Long spacings of 6 pure n-paraffins containing an even number of carbon atoms were measured with an X-ray diffractometer. Application of a 3-year incubation period at 37.5 F permitted unequivocal characterization of the stable crystalline modification for each compound and substantiated the purity of the samples as well. Published result is the free separate, "The Stable Crystal Structures of Pure n-Paraffins Containing an Even Number of Carbon Atoms in the Range C_{20} to C_{28}." *Mellon Institute.*

Circle number (59) on reply card.

Water Treating Equipment Guide

Presents latest developments in manual and automatic zeolite water softeners, demineralizers and deionizers, dealkalizers, ion exchangers, filters, purifiers, aerators and degasitors. Also covers spray and tray type deaerating heaters and water treating chemicals for every need. Guide is an unusually complete presentation of most recent types of equipment employed for treating water and the basic operating principles of each. Written and illustrated in easy-to-understand style. *Elgin Softener Corporation.*

Circle number (60) on reply card.

Plastic Catalog

Nation's largest warehouse distributor of plastics has published a 64-page catalog of plastic sheets, rods, tubes, films, blocks and flat tubings. Cements, pigments and miscellaneous supplies are also listed. Lists available sizes, weights, color ranges, textures, purchasing specifications, grades and prices. Includes 2-page comparison table of chemical, electrical and mechanical properties. *Cadillac Plastic & Chemical Company.*

Circle number (61) on reply card.

Imidazole Derivatives Bulletin

Preliminary technical data bulletin describes process to produce various imidazole derivatives. These compounds possess a high degree of stability because of their molecular structure. Said to be very stable 5-membered, hydrocarbon ring structures containing a tertiary nitrogen and a secondary nitrogen plus 2 double bonds, giving great versatility for end-product usage. Are of potential interest as intermediates in the fields of pharmaceuticals, metals deactivation, fungicides, optical bleaches, surfactants, bactericides and textile dyestuffs. *Houdry Process Corporation.*

Circle number (62) on reply card.

Mechanical Seal Catalog

Types, descriptions, and properties, as well as illustrations of various Dura Seals (mechanical seals) are provided in a revised catalog by *Durametallic Corp.*

Circle number (63) on reply card.

Rubber Impellers Sheet

Rubber impellers for self-priming pumps, precision-molded of new compounds and in new designs, are described in a 2-color illustrated catalog sheet. Reported to have a service life up to 1½ times longer than standard impellers, the PMP units are available in standard or special sizes, suitable for pumping capacities from ½ to 120 gal per min, speeds from 200 through 6000 rpm, and temperatures from 40 to 170 F. *Pacific Moulded Products Company.*

Circle number (64) on reply card.

Aluminum Welding Book

Comprehensive survey of techniques of welding aluminum using Air Reductions Aircomatic (gas-shielded metal-arc) and (Heliweld tungsten-inert-gas) processes is available in a 120-page spiral bound book. Thoroughly covers the entire subject from a brief historical note on first uses of these processes to highly specialized aluminum fabrications of today. *Air Reduction Sales Company.*

Circle number (65) on reply card.

"Sulfur Recovery" . . .

is a new booklet describing economical recovery of sulfur from hydrogen sulfide, and simultaneous alleviation of air pollution problems. Process information, yields and utility requirements are included, together with a flow sheet and photographs of typical plants for recovery of sulfur from hydrogen sulfide removed during purification steps in natural gas and refinery operations. *Girdler Construction Division, Chemetron Corporation.*

Circle number (66) on reply card.

Check Valve Circular

Illustrated, 2-color circular describing Lunkenheimer check valves lists, with specifications, some of the many types of check valves in the line—bronze, iron and steel for boiler feed lines for air, water and steam lines; and for controlling chemical and gaseous fluids. *Lunkenheimer Company.*

Circle number (67) on reply card.

Water Treatment Bulletin

Describing its complete line of water treatment equipment, the bulletin issued by Process Engineers, Inc., features the reactor-clarifier, a development which combines coagulation and flocculation, sedimentation and sludge removal in a single unit. *Process Engineers, Inc., Division of The Eimco Corporation.*

Circle number (68) on reply card.

World-Wide Guide . . .

to equipment and technical services, 1959 edition, has been published by Dresser Industries. The colorful, 68-page book is profusely illustrated and provides reference to the many products and services supplied by the Dresser group of companies throughout the world. Convenient lists of representatives and their addresses in various countries are also included. *Dresser Industries, Inc.*

Circle number (69) on reply card.

Heat Exchanger Catalog

New edition explains where Trufin, the integral finned tube, should be used, how fins affect the design of heat exchangers and fouling factors, and a comparison of Trufin and bare tube exchanger costs. Also included are helpful bare tube-to-Trufin conversion charts for various alloys. Primarily designed for persons interested in improved heat exchanger design. *Wolverine Tube Division, Calumet & Hecla, Inc.*

Circle number (70) on reply card.

New Literature

"The Plant You Want to Build" . . .

is the title of a new informative brochure for selective distribution to engineers and executives in process and manufacturing industries and those engaged in the chemical, petrochemical and petroleum refinery fields in which Foster Wheeler is already known. The 24-page institutional-type piece interestingly details the character and worldwide range of process engineering services offered. Fast-reading and well illustrated, it lucidly describes how the company has integrated facilities of its domestic and foreign subsidiaries to flexibly provide optimum organization to design, or engineer, or erect whatever plant is desired . . . any process . . . any size . . . anywhere in the world. *Foster Wheeler Corporation.*

Circle number (71) on reply card.

Butynediol Review

Comprehensive booklet presents physical and chemical properties of butynediol and discusses its industrial applications. Information is also given on storage and handling. Butynediol is a new intermediate which is prepared by a high-pressure acetylene process. Illustrated, 40-page booklet is available on request. *Antara Chemicals, General Aniline & Film Corporation.*

Circle number (72) on reply card.

Arc Welding Data Card

Fabricators who are confronted with the problem of joining tubing of similar or dissimilar types of steel by welding, will benefit by information contained in a new data card which summarizes various recommendations for arc welding. Besides indicating the proper type of electrodes to be used, it provides information on suggested pre-heat and post-heat treatments. Steels discussed are carbon steels, chromium-molybdenum alloy steels and stainless steels. Data card, TDC-155, is available without charge. *Tubular Products Division, The Babcock & Wilcox Company.*

Circle number (73) on reply card.

Threading Head Bulletin

Includes detailed information and specifications on the JN Landex die head suitable for application to automatic screw machines, chucking machines or other machines incorporating a revolving threading head, and the DE Landmatic specifically designed for application to Brown and Sharpe automatics. *Landis Machine Company.*

Circle number (74) on reply card.

Tubing Folder

Engineers and others involved in design and operation of heat transfer equipment using tubing at elevated temperatures and pressures will be interested in the data contained in a 4-page folder released recently. It furnishes condensed data on the mechanical and physical properties of seamless and welded carbon steel pressure tubing, and supplies information on various fabrication operations normally performed on such tubing. *Tubular Products Division, The Babcock & Wilcox Company.*

Circle number (75) on reply card.

Miniature Floodlight Catalog

Pocket-sized edition of the Floodlight Catalog includes all original material on floodlight selection, types, lighting, accessories and installation. Bulletin 2714 is available from *Crouse-Hinds Company.*

Circle number (76) on reply card.

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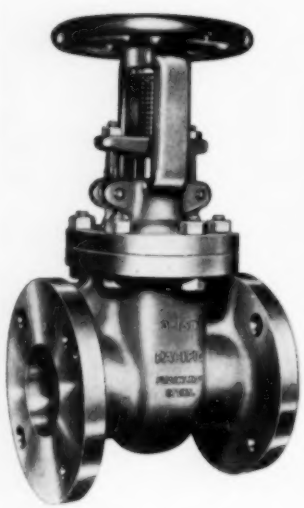

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New Literature

Linear Conversion Table . . .

for handy reference by engineers, purchasing agents and others who convert inches and fractions of inches into decimal parts of a foot has been issued. It is suitable for many purposes in addition to its application to steel tubing. Available without charge. *Tubular Products Division, The Babcock & Wilcox Company.*

Circle number (77) on reply card.

Coatings Chart

Designed to aid engineers and maintenance personnel concerned with buying and specifying corrosion resistant maintenance protective coatings, chart compares 17 standard systems showing strong and weak points of each. Accurate resistance ratings are listed for acid, alkali, solvent and water, weathering, flexibility, impact and abrasion, and temperature conditions. Compatibility over old paint, surface preparation and general comments are included. *Carboline Company.*

Circle number (78) on reply card.

Catalyst Bulletin

Information on its G-43 platinum-base hydrogenation catalyst is available in a new bulletin from Girdler Catalysts. Applications described include promoting reactions of oxygen and oxides of nitrogen with hydrogen, carbon monoxide, methane, propane or other hydrocarbons. Previous uses of the catalyst in commercial applications are also given. *Girdler Catalysts, Chemetron Corporation.*

Circle number (79) on reply card.

Now Available

. . . a 14-page brochure describing installations and applications of the Burroughs 205 electronic digital computer system in the petrochemical industry. Applications cover exploration and production; manufacturing and refining; transportation and pipelines; and accounting and marketing. *Burroughs Corporation, ElectroData Division.*

Circle number (80) on reply card.

Process Brochure

Brochure on the Hoechst HTP Process has been prepared by the parent company, Farbwerke Hoechst AG., in conjunction with the Fifth World Petroleum Congress. First plant for the production of acetylene and ethylene, using the process is under construction at the company's main plant in West Germany. *Hoechst-Uhde Corporation.*

Circle number (81) on reply card.

"Ammonia" Edition

Efficient production of ammonia under a pressure of 35 atmospheres is described in a new booklet, "Ammonia," new addition to the Gas Process Booklet series. Starting with prepared synthesis gas mixtures, booklet provides process information, a flow sheet and photographs of Girdler-built ammonia plants. *Girdler Construction Division, Chemetron Corporation.*

Circle number (82) on reply card.

Gage Catalog

Four-page brochure describes new line of solid front pressure indicating and test gages which are housed in a rigid case with integrally cast front shield to protect personnel in the event of a blowout. Complete construction details with diagrams and photos are given. *Crosby Valve & Gage Company.*

Circle number (83) or reply card.

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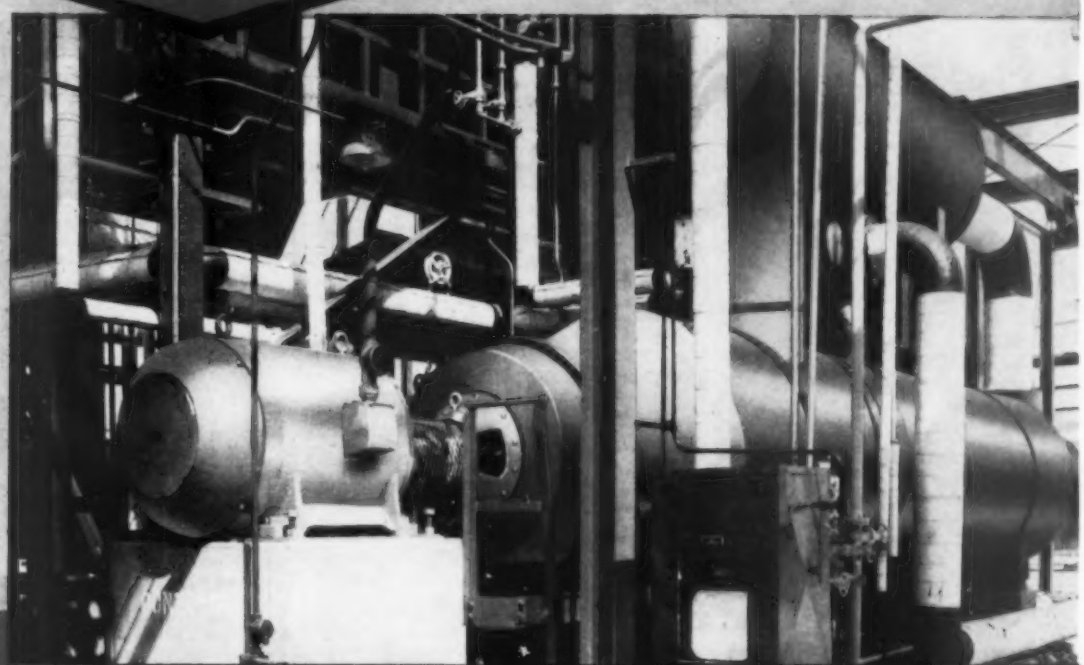

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Refining Notables

Dr. Alex G. Oblad

In 1937 when **Dr. Alex G. Oblad** took his advanced degree in chemistry at Purdue University, it was the beginning of a career so rich in scientific and professional accomplishments that 22 years later the same university felt that an honorary degree was in order. It is a sign of academic recognition to the oil and chemical industry as well as to the individual.

Written record of Dr. Oblad's creative activity includes over 70 patents and technical publications. His scientific contributions now utilized throughout the world reflect Dr. Oblad's philosophy of flexibility, cooperation and diversification which has also governed his direction of research and development at The M. W. Kellogg Company as vice president.

Dr. Oblad's scientific work resulted in advances of understanding the fundamental nature of catalysis and chemical kinetics, as well as new processes of great importance to the petroleum industry. He has directed various nuclear and metallurgical research programs.

Since joining M. W. Kellogg in 1957, Dr. Oblad has spent considerable time in building a research and development group which reflects his own philosophy. This has meant organizing highly creative people into a team able to handle a wide variety of projects which operate upon common technical principles. His objective is twofold: First, to have available a group which can engage in cooperative research with other companies in any of the process industries, and second, to achieve higher productivity in new process developments. Dr. Oblad foresees, however, no decrease in the application of his group's efforts to Kellogg's established activities in the petroleum field. He hopes instead to make more efficient utilization of valuable scientific and engineering talent.

Before coming to Kellogg, Dr. Oblad was vice president of Houdry Process Corporation. He has also been associated with Magnolia Petroleum Company, Texas Research Foundation and Standard Oil Company (Indiana).

Despite heavy commercial and industrial management responsibilities, he has served actively as a member of the American Chemical Society, in which he held the posts of secretary-treasurer and chairman of the Division of Petroleum Chemistry. He is currently managing editor of Division publications and chairman of the society's Division Officers Group, and member of the board of trustees of Universal Finance Corp., Dallas.

"Throughout his career, he has always reserved part of his time and energy for family and friends, for religious pursuits, for civic services, and for the guidance of young students and scientists — many individuals are indebted to him for help and advice," cited the commendation.

REFINING PERSONALS

▸ **J. T. Higgins** has been appointed vice president, director and general manager of manufacturing for Standard Oil Company of California, Western Operations, Inc. He succeeds **Fred Powell** who was recently named president and chief executive officer of California Chemical Company. Higgins will coordinate Standard's manufacturing activities at refineries in Richmond, El Segundo and Bakersfield, California, and at the new refinery presently under construction near Honolulu, Hawaii.

J. T. Higgins

F. M. Gibbons

▸ Joining Commonwealth Services, Inc. as supervisor of oil refining and petrochemical consulting activities, **Frank M. Gibbons** is stationed in the Houston, Texas, office. He was formerly project manager for oil refinery engineering and construction at Fluor Corporation, Ltd., and has also worked as project engineer for Bechtel Corporation.

▸ Two University of Texas chemical engineering faculty members, **Drs. William A. Cunningham** and **Howard F. Rase,** have been elected national officers of Omega Chi Epsilon, honorary chemical engineering society. Dr. Cunningham was named president, and Dr. Rase was re-elected treasurer. Dr. Cunningham formerly served as national secretary.

▸ **L. A. Lohman,** administrative superintendent at Shell Oil Company's Wood River refinery, retired August 1 after more than 29 years with the firm. He was succeeded by **V. G. Harrison,** former administrative superintendent at Shell's Norco, Louisiana, refinery.

L. A. Lohman

P. R. McArthur

▸ **Peter R. McArthur** has joined The Ralph M. Parsons Company, engineers-constructors, and will be responsible for business development in the petroleum, chemical and petrochemical industries. A graduate engineer, McArthur has been engaged for many years in a similar capacity.

▸ Appointed manager of Phillips Petroleum Company's natural gasoline department is **W. L. Culbertson,** who joined the company in 1939 and has been assistant manager of the department since 1956. His appointment fills the vacancy created by the promotion of **G. W. McCullough** to vice president, natural gasoline.

▸ 1959 recipient of the Professional Progress Award of AIChE is **Dr. W. R. Marshall Jr.,** professor of chemical engineering and associate dean of the University of Wisconsin College of Engineering, and associate director of Wisconsin's Engineering Experiment Station. The $1000 award and certificate, sponsored by the Celanese Corporation of America and awarded by the Awards Committee and Council of the AIChE, is given annually to a chemical engineer in recognition of his "outstanding progress in the field of chemical engineering."

The award will be presented at the AIChE annual meeting in San Francisco, December 6-9. Professor Marshall will deliver the main address.

J. McDonald

C. A. Phillips

▸ Major appointments made by Tidewater Oil Company are:

James McDonald as assistant division general manager of the western division embracing the seven western states and Hawaii, and **Clifford A. Phillips** to succeed him as administrative manager of manufacturing.

M. David Haynes has been named assistant manufacturing manager of the eastern division and **E. L. Raun** has been appointed refinery superintendent at the Delaware refinery to succeed him.

M. D. Haynes

E. L. Raun

▸ **J. G. Schaafsma** recently marked 25 years of service with General Petroleum Corporation. He became manager of the laboratories department in 1955 with headquarters at Vernon, California.

Appointment of **John A. Boege** as assistant to the director of manufacturing has been announced. He had been manager of the manufacturing department's Vernon headquarters.

▸ Appointment of **E. F. Grieb** as manager of American Cyanamid Company's Fortier plant at New Orleans, Louisiana, has been announced. He succeeds **C. F. Bonnet,** who has been named associate regional director-Europe of Cyanamid International, the firm's overseas operating division. **T. D. Smith** has been named assistant plant manager and **J. J. Fitzgerald** has been appointed manager of operations.

▸ Canadian Oil Companies, Ltd. has announced executive appointments in the company's producing department at Calgary, Alberta.

W. M. Luthy, formerly development manager, has been appointed manager of the producing department and assumes full responsibility for that phase of the company's operation. **H. G. Bagnall,** previously operations manager, has been promoted to assistant manager.

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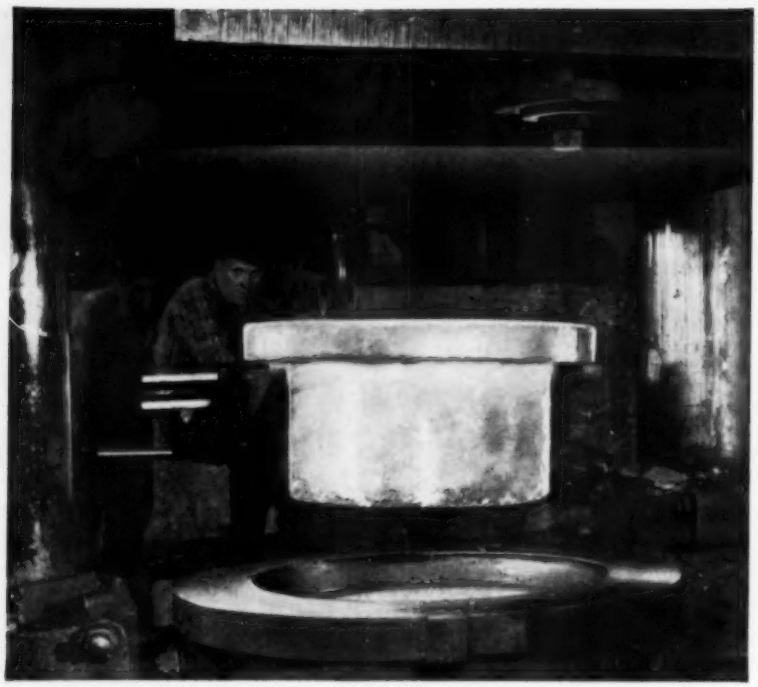

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See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

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Personals

▸ Thirty years of service with Shell was celebrated by **A. J. Johnson,** vice president of the Development and Engineering Division of Shell Development Company's Emeryville Research Center. For 15 years he has directed development of processes and engineering research for Shell Development in the petroleum and petrochemical fields. Development and design of the world's first synthetic glycerine plant — which won the Chemical Engineering Award in 1948 — was under his direction. He began his career at Shell's refinery at Norco, Louisiana, in refinery operation, management and plant design before going to Shell Development as chief engineer in 1940. He was appointed vice president four years later.

▸ **Robert D. Bent** has been appointed general manager of manufacturing at The Atlantic Refining Company, succeeding **W. F. Stroud,** who has retired after nearly 43 years with Atlantic. Stroud had been a vice president and general manager of manufacturing since 1952, and a director of the company since 1955. He will continue as a director.

R. D. Bent

Bent had served as assistant general manager since February. He joined Atlantic's research and development department in 1935 and in 1953 was named director of the development division. In 1958 he was transferred to manufacturing as manager of the technical service department.

▸ **Dr. Alan Schriesheim** has been appointed a research associate at Esso Research and Engineering Company. A member of the firm's process research division, Dr. Schriesheim does exploratory research concerned with catalysis. Before joining Esso Research in 1956, he was a research chemist with the National Bureau of Standards in Washington.

Glenn A. Pine, Dr. Richard M. McKinley and **Raymond C. Lohman** have joined the technical staff of the Esso Research Laboratories, Baton Rouge, Louisiana.

▸ **Richard C. McCurdy,** president of Shell Chemical Corporation and a director of Shell Oil Company, has been elected a member of the executive committee of Shell Oil Company.

▸ Promoted to senior research chemical engineer in Humble Oil & Refining Company's Research and Development Division at Baytown, Texas, is **E. C. Winegartner,** who is engaged in research on corrosion. **Dr. R. T. Moravek** is now senior research chemist.

D. R. Moore has been promoted to senior chemical engineer in the technical division at the Baytown refinery. He is presently serving in the company's executive development program as head of the catalytic cracking section.

▸ **Herman G. Gunter** has joined Commonwealth Oil Refining Company, Inc. as assistant refinery manager. He has been associated with Standard Oil Company (New Jersey), Suntide Refining Company and Commerce Oil Refining Corporation.

▸ Standard Oil Company (Indiana) has announced the appointment of **Dr. Reimer E. Probst** as group leader. He will be in charge of information research at the Whiting research laboratories.

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The Century Ahead

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ACCESSORY ROLL—1½ inch I.D. Core—100, 200, 300 ft. length—Price Per Square, Dollars

Quantity, Squares	Less than 102	102 to 500	501 to 1499	1500 to 2999	3000 to 5000	5001 to 25001	25002 and Over
No. 900 Black, 14 mils. No. 910 Gray, 12 mils. No. 940 Black, 12 mils. No. 940 Gray, 12 mils.	13.66	12.20	11.02	9.76	8.54	8.04	7.62
No. 920 Black, 20 mils.	19.30	17.22	15.56	13.78	12.06	11.38	10.76

PIPELINE ROLL—3 inch I.D. Core—400, 600, 800 ft. length—Price Per Square, Dollars

Quantity, Squares	Less than 102	102 to 500	501 to 1499	1500 to 2999	3000 to 5000	5001 to 25001	25002 and Over
No. 900 Black, 14 mils.	13.66	12.20	11.02	9.76	7.90	7.44	7.04
No. 920 Black, 20 mils.	19.30	17.22	15.56	13.78	11.16	10.52	9.95

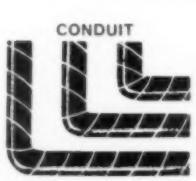
Polyken®

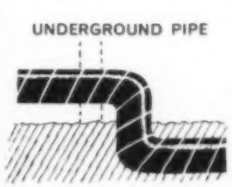
Experienced in modern PROTECTIVE COATINGS

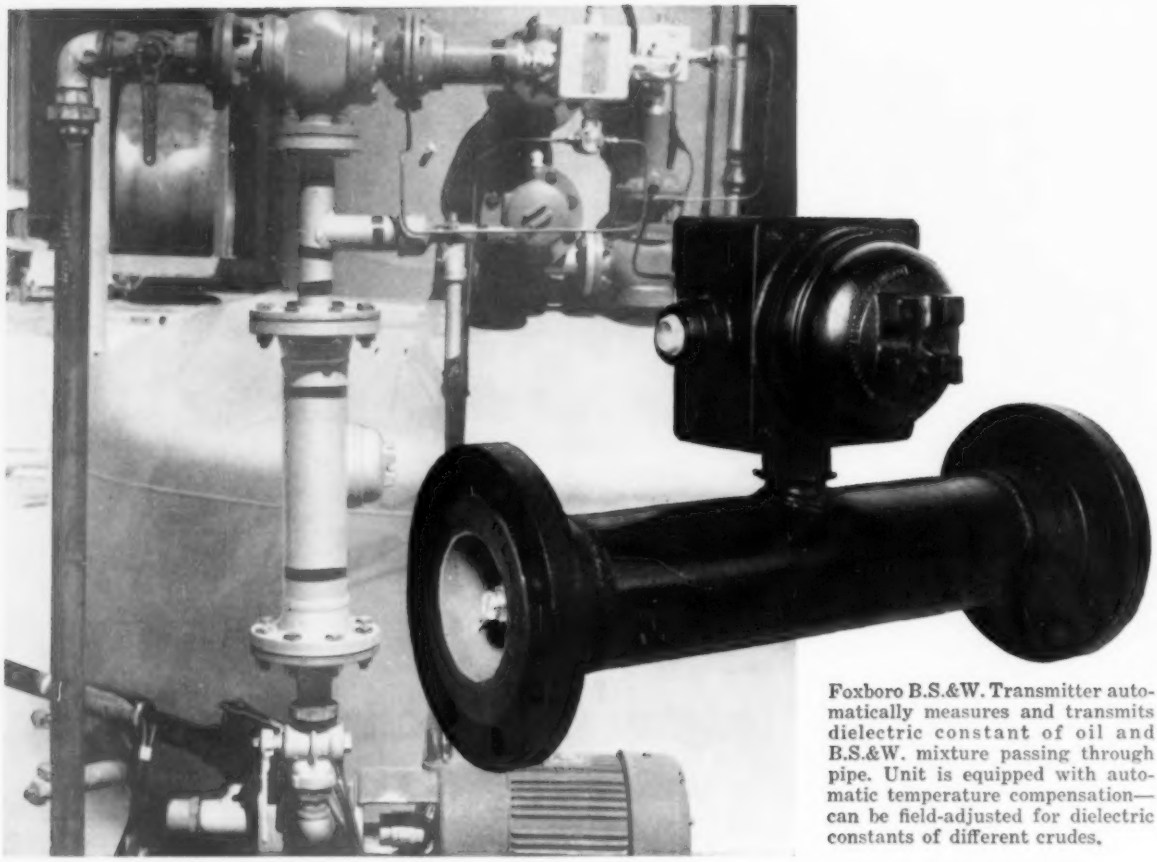
THE KENDALL COMPANY

Polyken Sales Division

CHECK THESE DANGER POINTS IN YOUR PLANT *(and protect 'em with Polyken)*







Foxboro B.S.&W. Transmitter automatically measures and transmits dielectric constant of oil and B.S.&W. mixture passing through pipe. Unit is equipped with automatic temperature compensation—can be field-adjusted for dielectric constants of different crudes.

unique Foxboro system gives continuous, unattended measurement of B. S. & W.

— *plus records to prove it.*

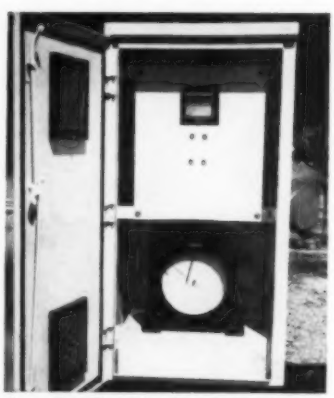
The instant the B.S.&W. content of crude oil exceeds preset percentage you know it, with this unique Foxboro monitoring system.

Here's how. A Foxboro measuring element, installed in the pipeline, continuously measures B.S.&W. content of the crude, in terms of dielectric constant. Changes in dielectric are then transmitted electrically to a Foxboro capacity Dynalog* Recorder.

And that's it. Remedial action can be incorporated by having the Dynalog Recorder equipped with an electric contact for sounding an alarm or operating diversion valves to re-route off-spec oil.

Not only does the Foxboro B.S.&W. System fully meet the specifications of A.P.I. Bulletin 2509A, but also it is the most accurate, automatic, and trouble-free method of policing B.S.&W. available. Ask your nearby Foxboro sales engineer for details. He can tell you about dozens of these systems now at work throughout the world. **The Foxboro Company, 388 Norfolk Street, Foxboro, Mass.**

*Reg. U. S. Pat. Off.



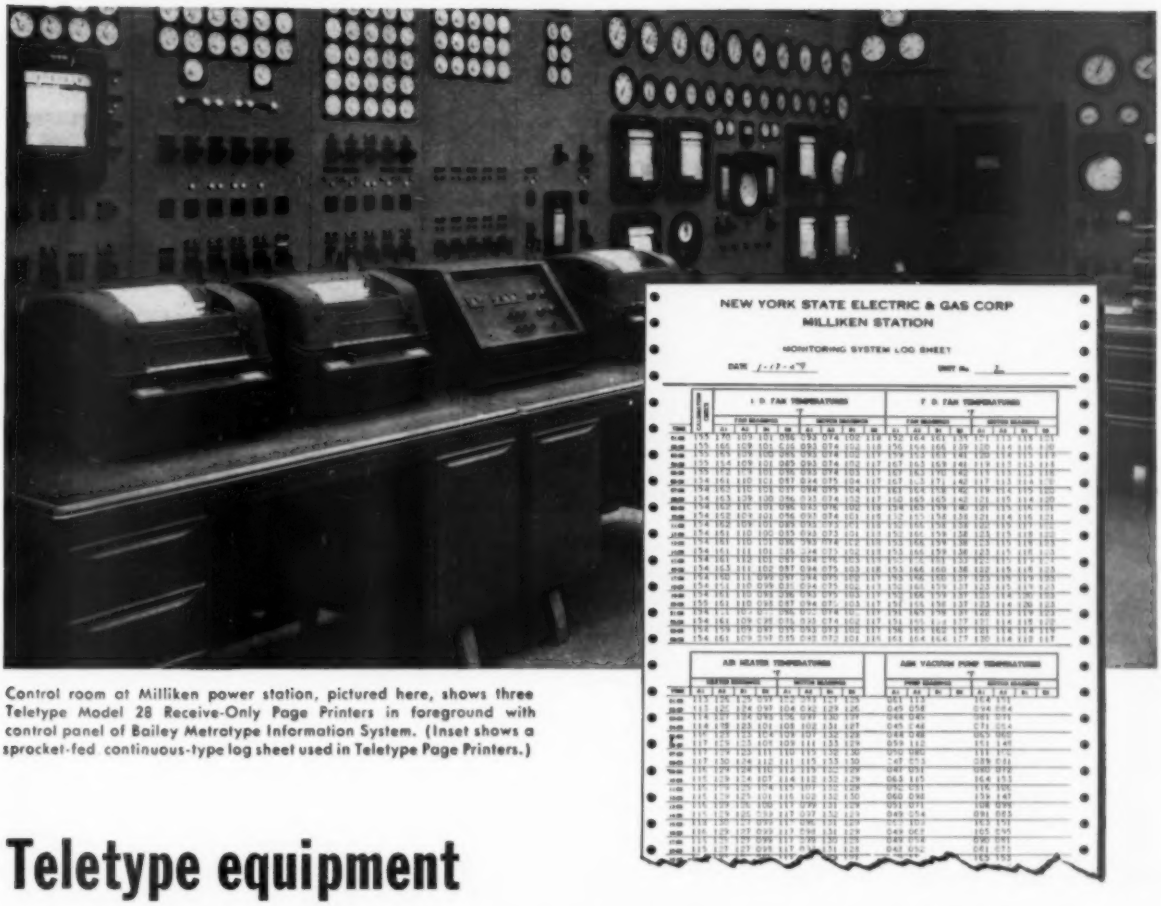
Capacity Dynalog Recorder (lower instrument) receives measurement from B.S.&W. Transmitter, records it, and initiates alarms or re-routing of oil flow.

FOXBORO instrumentation

REG. U.S. PAT. OFF.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Automatic read-out . . .



Control room at Milliken power station, pictured here, shows three Teletype Model 28 Receive-Only Page Printers in foreground with control panel of Bailey Metrotype Information System. (Inset shows a sprocket-fed continuous-type log sheet used in Teletype Page Printers.)

Teletype equipment monitors and records power station performance

New Model 28 Teletype Page Printers and Tape Punch equipment provide a continuous, dependable data processing facility for evaluating power station performance. This Teletype communication equipment is part of a Bailey Meter Company Metrotype® Information System installed recently at the Milliken power station of the New York State Electric & Gas Corporation, near Ithaca, New York.

This installation consists of two data systems:

1. A Monitoring System that continuously scans a total of 282 variables—temperatures of fan, motor and pump bearings; pressures of water and oil pumps, etc. Whenever readings exceed prescribed limits, system immediately reads and prints complete digital data of off-normal operation. In addition, complete readings are printed hourly.

2. A Performance System that scans 66 points once every hour, measures generator output, main steam flow, feedwater flow, temperatures, etc. All factors required to evaluate the station's performance are logged on the Teletype Printers. A Teletype Tape Punch also produces a perforated tape for IDP.

Robert Darke, Systems Division Manager, Bailey Meter, says, "Teletype equipment was chosen for this installation because of its flexibility and proven reliability. Design is simple and trouble-free, and the units are manufactured specifically for round-the-clock rather than intermittent service."

Teletype equipment will handle data for virtually any purpose in any industry. Signals may be serial or multi-wire. Signal medium may be local electrical circuit, telegraph or telephone circuit, or radio.

Why not find out how Teletype equipment can fit into your systems plan? Please write: Teletype Corporation, Dept. 90-H, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

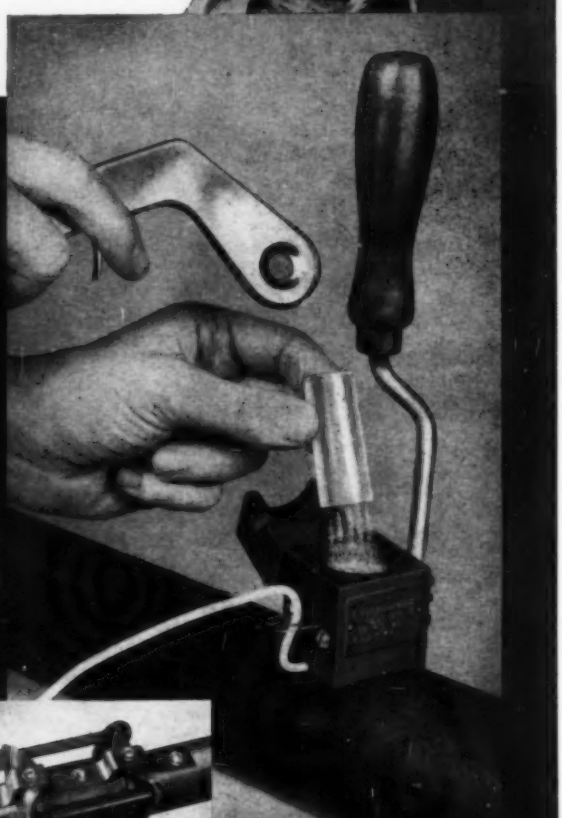
for cathodic protection...

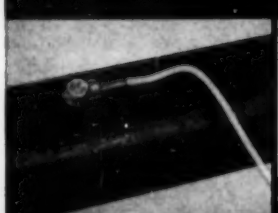
BURNDY thermOweld®

FIRES EVERY TIME!

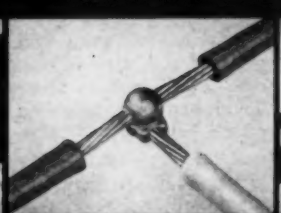
THE POWDER MAKES THE DIFFERENCE!

THERMOWELD's cohesive starting powder can't mix with the welding charge. This assures full-strength ignition that fires the welding charge every time. Just pour the welding charge from the moisture-tight cartridge into the Thermowelder and tap to release special starting powder. Ignite for perfect, permanent electrical weld connections—anode and header leads, jumper bonds, and other cathodic protection connections.





Anode Leads
Sounder, surer welds



Header Leads
Higher conductivity connections

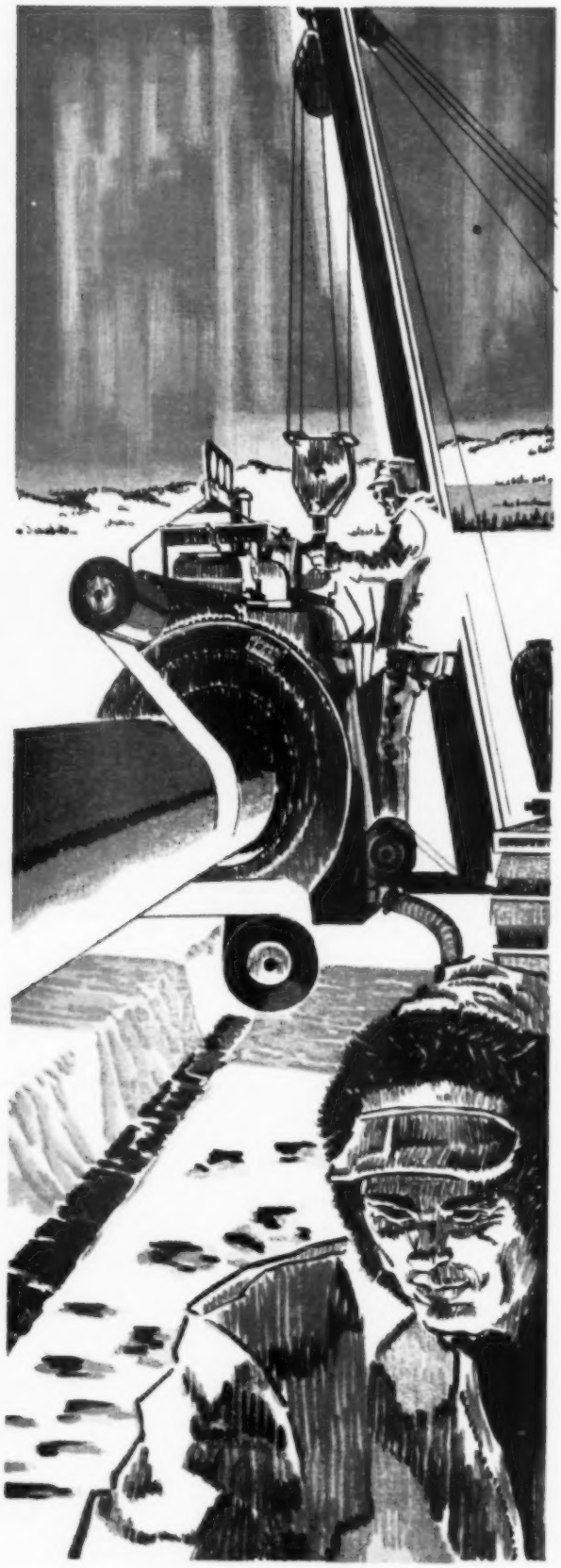
Jumper Bonds
Easier strap or cable bonds

For complete details on softer slag, sure-fire THERMOWELD connections for cathodic protection, call your Burndy representative or write: BURNDY, Norwalk, Connect.

BURNDY

57-10

Norwalk, Connect. In Europe: Antwerp, Belgium Toronto, Canada



CROSE

RECOGNIZED AS THE BEST PIPELINE CONSTRUCTION EQUIPMENT

...anywhere!

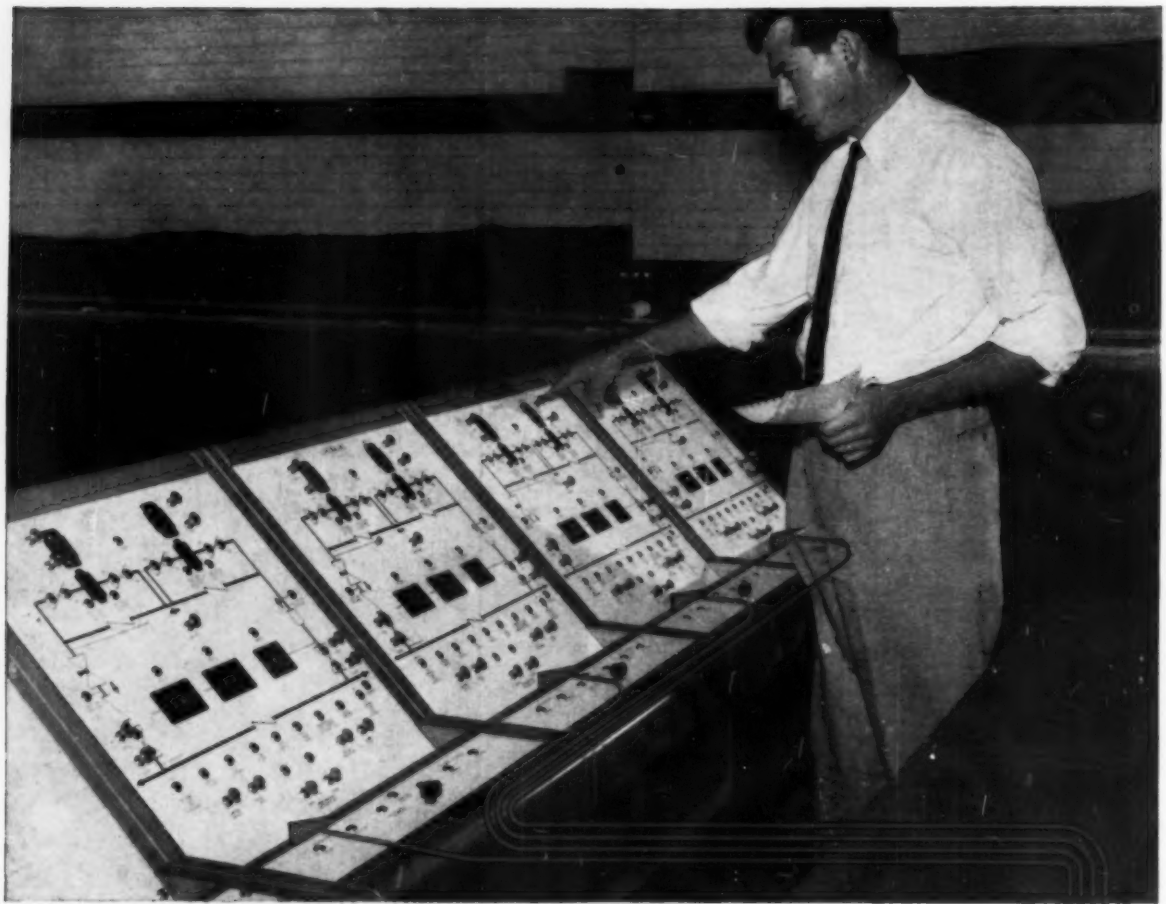
This is the kind of country that brings out the best in men and the rugged Crose equipment they depend upon for pipeline construction work under severest weather conditions. Whether you're line traveling across the cold, barren northlands, or the burning desert sands, you can be sure that Crose equipment has been designed and built for the toughest jobs. Pipeliners the world over have found this to be true.

Crose
MANUFACTURING COMPANY, INC.

2765 DAWSON ROAD • PHONE WEBSTER 6-2171 • TULSA, OKLAHOMA BRANCH OFFICES: HOUSTON • DENVER • ELIZABETH, N. J. IN CANADA: CROSE-CURRAN LTD., EDMONTON, ALBERTA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Union Centralized Transport Control pays



LOS ANGELES CONTROLLING OFFICE—The heart of the whole operation is in Los Angeles where one man at the control console can supervise the operation of four unattended pump stations 643 to 804 miles away. The operator has complete information before him showing conditions all along the line.

PHOENIX
Output Terminal

TUCSON
Output Terminal

APACHE
Unattended Booster Pump Station

REMOTE CONTROL—Either pumping unit at any one of the four booster stations can be started or stopped from Los Angeles. The sequence in opening and closing valves and starting and stopping pumps is all handled automatically and correctly by the control system.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

off for Southern Pacific Pipe Lines

Push a button in Los Angeles and four pump stations throb into action out on the desert over 600 miles away

Union Switch & Signal equipment controls operating sequence and telemeters operation of 33,000 bbl/day products line

FLEXIBILITY and fail-safe operation are the keynotes of the new pipeline system operated by Southern Pacific Pipe Lines, Inc. The line is used to transport refined products such as gasoline, jet fuel, diesel oil, etc., from El Paso, Texas, to Tucson and Phoenix, Arizona. All Centralized Transport Control equipment for four unattended booster stations was supplied by Union Switch & Signal.

REMOTE or LOCAL: All four booster stations are normally controlled from Los Angeles. Any station can be controlled locally, when desired. In any case, continuous pressure and suction readings are displayed on the console at Los Angeles and automatically recorded every fifteen minutes by an automatic typewriter. Any malfunction, at any point in the system, is indicated on the console. The equipment affected is shut down automatically and cannot be started again until the trouble has been cleared.

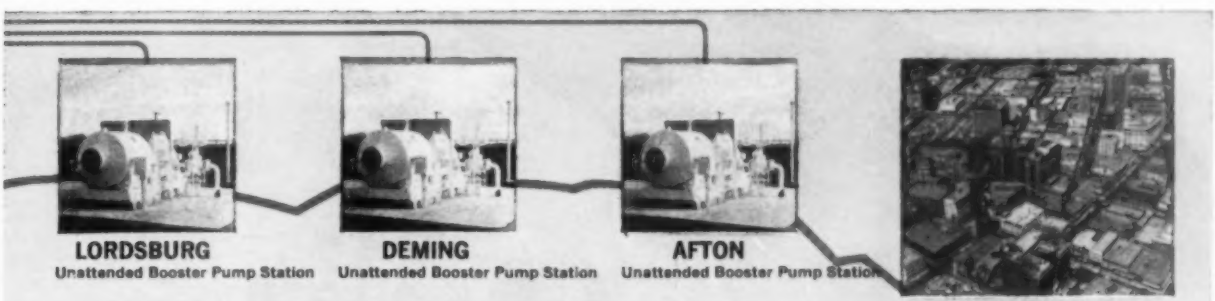
COMMUNICATION: Four telegraphic-type communications lines, owned by Southern Pacific, are used to transmit control codes to the stations and telemetered information back to Los Angeles. Each line serves one station. An additional commercial communications line serves as a stand-by for all four stations. Signals are coded to prevent noise or interference from causing faulty operation or indication.

MAXIMUM EFFICIENCY: The Centralized Control system, designed and installed by Union Switch & Signal Division of Westinghouse Air Brake Company, cuts down the chance for expensive error. It keeps the Southern Pacific Scheduling Department in Los Angeles informed, at all times, of exactly what is happening in the field. It speeds operation, adds security and reliability.

Union Switch & Signal has designed many successful custom systems for pipeline companies. And now out of that experience, it has developed standardized central control systems that cut costs, add flexibility, and save space, as well as making pipeline control extremely reliable.

"Pioneers in Push-Button Science"

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA



LOCAL CONTROL—Operation also can be controlled automatically at the pump station. Or the station can be run manually. The choice is up to the local station. But Los Angeles always knows which mode of control is being used and always receives a continuous flow of system information.

THE FUTURE—Southern Pacific Pipe Lines, Inc. can already see opportunity to make this system more automatic and more efficient. They plan, in time, to be able to let stations adjust automatically to proper unit operation when an upstream or downstream station goes off the line.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PROTECTION IS A FULL TIME JOB

Specify Nicolet Asbestos Pipe Line Felts

Soil stress and corrosion are ever present threats along every inch of every pipe line. The protection these lines receive must be more than equal to the task of constantly combating abrasion, corrosion and earth movements.

Nicolet Asbestos Pipe Line Felts will give your pipe lines the maximum in protection—the safest, surest you can buy.

Uniformity of manufacture results in uniformity of performance. That is why you may be sure that every square of Nicolet Asbestos Pipe Line Felt will meet, to the full, all expectations and specifications.

For yard or over-the-ditch wrapping, Nicolet Asbestos Pipe Line Felts are your best buy.

Nicolet #15 Standard
#8 Tufbestos
Tar or Asphalt Saturated
With or without Glass Reinforcement
Plain or Perforated
2" or 3" cores
and
Nicolet Reflecto Asbestos Pipe Line Felt—the White, Rubberized all purpose felt.

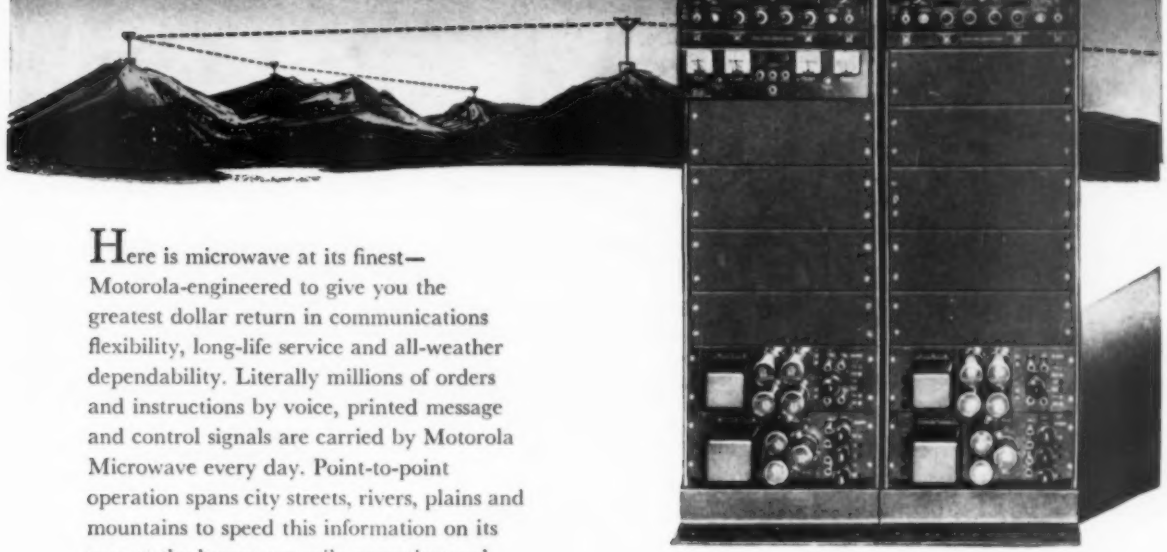
NICOLET INDUSTRIES, Inc.
FLORHAM PARK, NEW JERSEY

District Sales Offices
Ford & Washington Streets,
Norristown, Pa.
P.O. Box 777
Hamilton, Ohio

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MR-20 MOTOROLA MICROWAVE

...means more multi-channel, point-to-point efficiency for each communications dollar



Here is microwave at its finest—Motorola-engineered to give you the greatest dollar return in communications flexibility, long-life service and all-weather dependability. Literally millions of orders and instructions by voice, printed message and control signals are carried by Motorola Microwave every day. Point-to-point operation spans city streets, rivers, plains and mountains to speed this information on its way at the lowest per-mile operating and maintenance costs.

Simple, "building-block" components—Motorola MR-20 and associated multiplex equipment—can be fitted to your communication need to provide for any combination of voice, control and data transmission, including 2-way radio operation. Let Motorola Microwave bring the full efficiency and the money-saving opportunities of just-right communications to your operations.

Send for illustrated Brochure 1188.

MR-20 Microwave RF equipment . . . even more simple and reliable for maximum dollar value

- **Automatic Switchover-Switchback** . . . provision available for bi-lateral switching where desired.
- **"Hot" Standby** . . . enables switchover to pre-heated unit in less than one second.
- **Simplified Waveguide** . . . allows additional RF channels to be multiplexed to common antenna.
- **Frequency Diversity** . . . provides maximum circuit continuity in 5925-6425 MC band.
- **Plus outstanding Motorola developments for 6000 MC operation** . . . explained in detail in Brochure 1188.

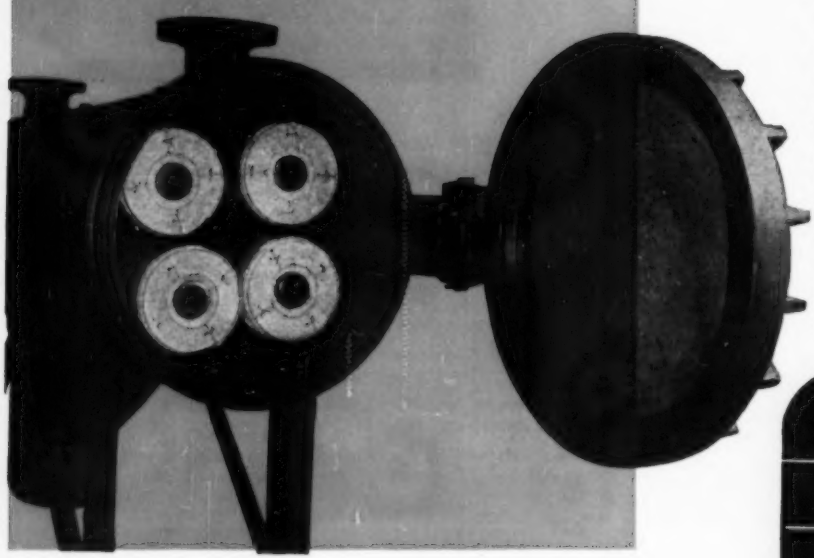
MOTOROLA MICROWAVE

Motorola Communications & Electronics, Inc., A Subsidiary of Motorola Inc., 4501 Augusta Blvd., Chicago 51, Illinois

EXCEL-SO

HP-700
CLUSTER
REPACK
SEPARATOR
STRAINER

. . . the only high volume pipeline strainer that removes free water from petroleum products!



The HP-700 is rated from 750 to 1000 GPM on gasoline and fuel oil. The four repack cartridges provide a total filtering area of approximately 5,500 square inches. This Separator-Filter effectively removes solid particles down to forty microns in size. Equipped with quick opening closures and other easy service features, this compact unit is designed especially for the pipeline industry. Write for detailed information.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF **FRAM** CORPORATION

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Reilly 230 X-1 Primer

QUICKLY

adds extra staying power to hot application fully plasticized enamels

It creates a bond between fully plasticized coal tar enamel and metal that strengthens as it serves... that, when properly applied, increases the reliability factor of the application process on steel pipe and tank surfaces to a comfortable 100%.

Reilly 230 X-1 Primer

Reilly 230 X-1 Primer is

1. Quick drying, 20 minutes ± in clean atmosphere at 70°F.
2. Non-sagging and non-curtaining.
3. Economical to use (750 to 1400 sq. ft. gal. coverage).
4. Derived wholly from coal tar materials.
5. Acceptable to A.W.W.A. and government standards.

Specify REILLY 230 A. W. W. A. enamel with 230 X-1 primer. Also, soon to come, HS X-1 for Hot Service and QD-X-1 for Intermediate enamel.

REILLY TAR & CHEMICAL CORPORATION

1615 MERCHANTS BANK BUILDING
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Reilly COAL TAR PRODUCTS
ARMEX Protective Coatings

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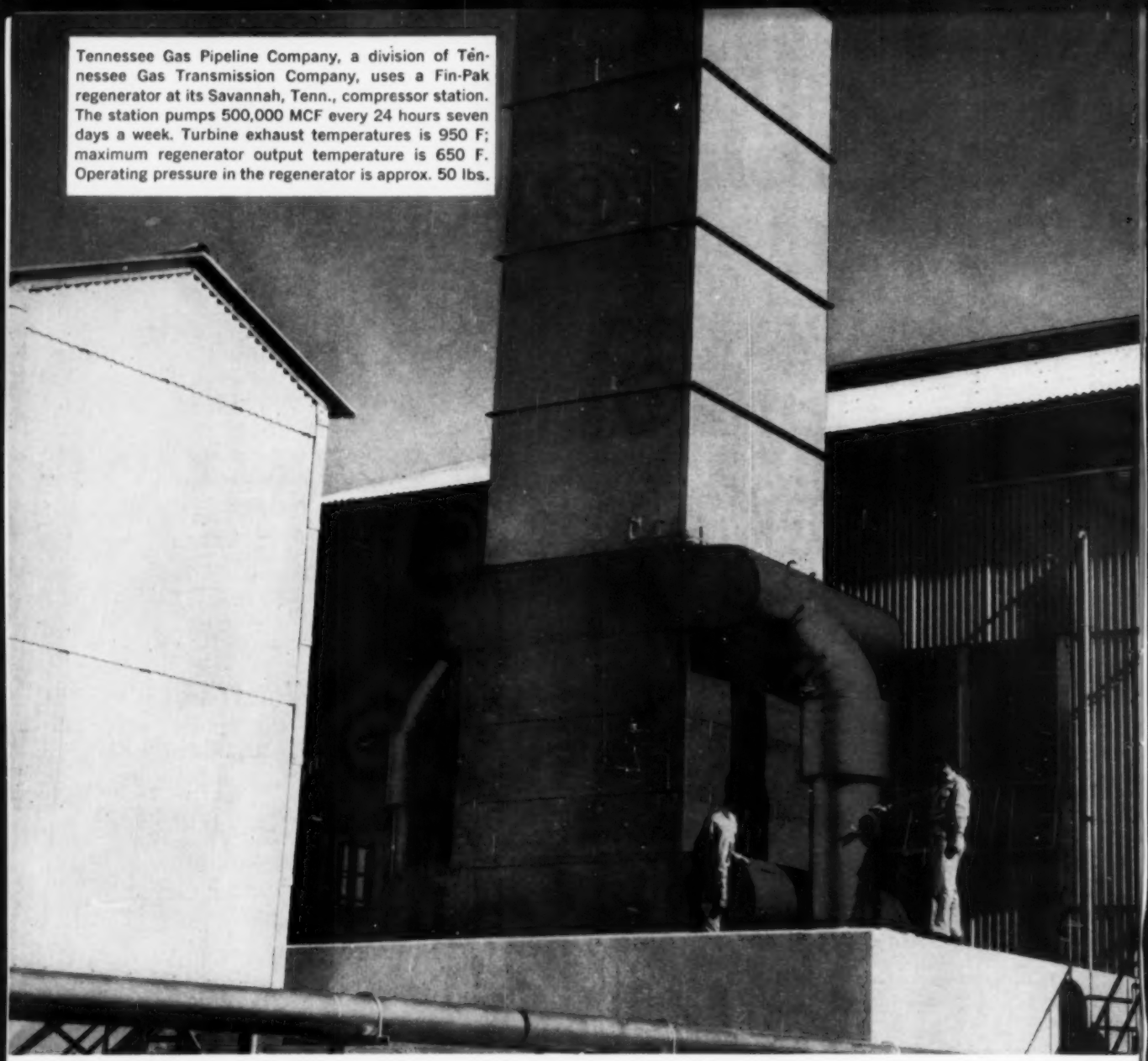


Tennessee Gas Pipeline Company, a division of Tennessee Gas Transmission Company, uses a Fin-Pak regenerator at its Savannah, Tenn., compressor station. The station pumps 500,000 MCF every 24 hours seven days a week. Turbine exhaust temperatures is 950 F; maximum regenerator output temperature is 650 F. Operating pressure in the regenerator is approx. 50 lbs.

FIN-PAK HEAT EXCHANGER CUTS FUEL COSTS 32%

An Air Preheater Fin-Pak can pay for itself in approximately 6 months *on fuel savings alone*. For example, a Fin-Pak with a designed effectiveness of 75%, in a gas turbine cycle at 6 to 1 pressure, and a turbine inlet temperature of 1500°F, can cut fuel costs by 32%. And the improved combustion you get with a Fin-Pak reduces residual carbon deposits, cuts maintenance of other equipment in the system.

Fin-Pak provides big installation savings, too. It's compact (takes less than half the space of tubular regenerators of identical capacity) and weighs 50% less than an equally efficient tubular unit — so it's easier to erect and needs less expensive support structure.

No maintenance is required, other than infrequent cleaning with compressed air. The Fin-Pak has short, straight-through passages that facilitate cleaning.

ONE LAST THOUGHT: A gas turbine station requires approximately 80% *less* plant maintenance personnel than a station of equal capacity operating with diesels, steam turbines or gas engines. You can economize still further by incorporating a Fin-Pak in the gas turbine cycle. For complete details, call or write The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

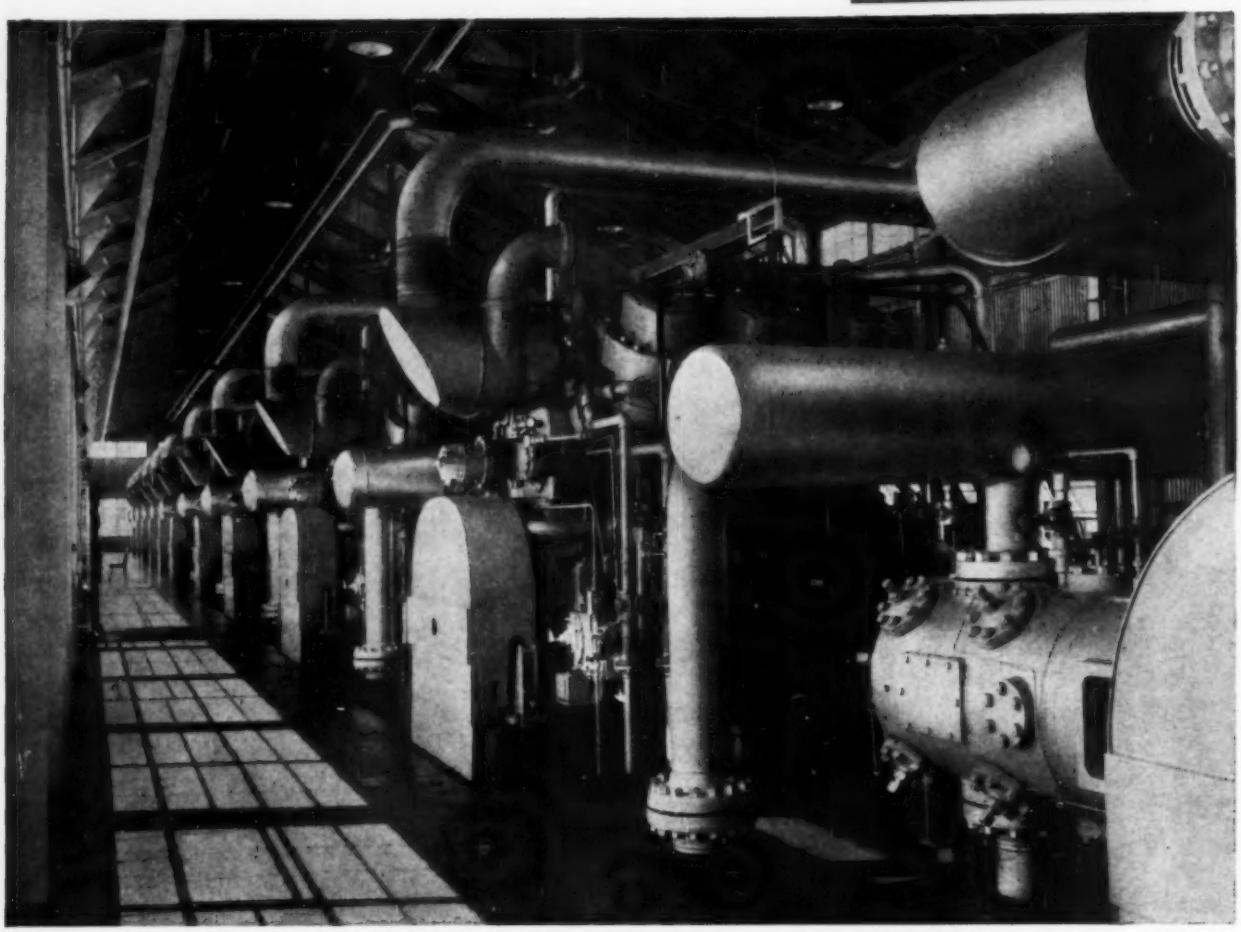
Adjust these clutches ***ONCE*** *...and they'll stay!*

On Bucyrus-Erie 22-B Hi-WALKERS, the clutches automatically compensate for temperature changes throughout the day. The operator doesn't have to stop three or four times to adjust them up so they'll hold. And next morning he'll start right in again and the clutches will be even and firm.

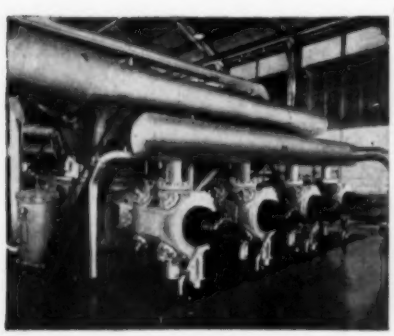
All main shaft and swing clutches on the 22-B Hi-WALKER are identical and their parts interchangeable. You don't need to carry along an expensive parts stock . . . one set of bands is your reserve.

Hi-WALKERS were specifically designed for pipelining. Get *all* the facts from your Bucyrus-Erie distributor, or write Bucyrus-Erie Company, South Milwaukee, Wisconsin, Dept. 35EB.

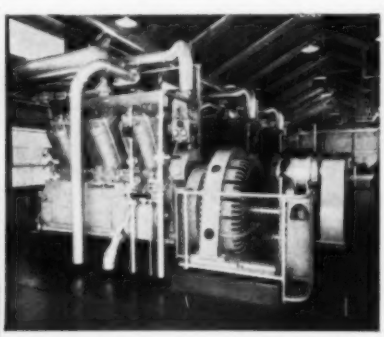
11 TURBOCHARGED KVS



Eleven Ingersoll-Rand turbocharged 4-cycle KVS gas-engine compressors, totaling 20,000 hp, in main compressor building of Michigan Consolidated Gas Company, Six Lakes, Mich. The two sizes of compressors are identical in operation and have almost complete parts interchangeability.



Compressor side of 2000-hp KVS unit, showing the "compound" clearance pockets in the head ends of the compressor cylinders. These, together with pockets in the frame ends, permit 4-step loading of each cylinder.



Three 408-hp Ingersoll-Rand PSVG gas-engine-generator units provide all electric power for the Six Lakes station. These dependable 4-cycle, V-angle gas engines offer the same flexibility of speed and load as the large KVS compressor units.

Two Ingersoll-Rand two-stage ES compressors supply starting air for the KVS gas-engine compressors and the PSVG engine-generator units. Both have overhead-mounted electric drive; one also has standby gasoline-engine drive.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

GAS-ENGINE COMPRESSORS

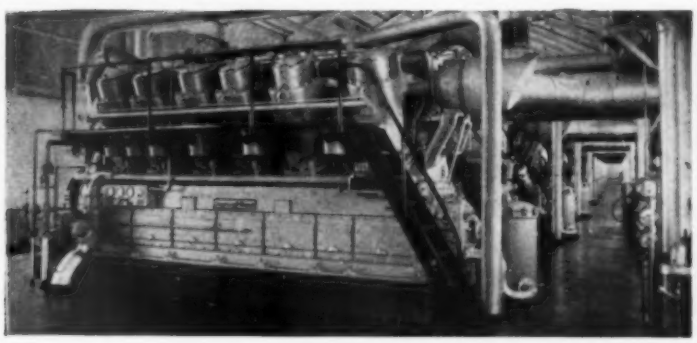
show ultimate flexibility

at Six Lakes Storage Field

Michigan Consolidated Gas Co. uses

from zero to 20,000 hp in many steps

with fluctuating pressures and capacities



One of nine 12-cylinder, 2000-hp turbocharged KVS compressors, from engine side.

One of two 6-cylinder, 1000-hp turbocharged KVS compressors, from engine side.

In the compressor station at Michigan Consolidated Gas Company's Six Lakes Storage Field, an all-Ingersoll-Rand installation provides the ultimate in loading flexibility. Two sizes of turbocharged 4-cycle KVS gas-engine compressors, with something new in capacity-control cylinders, allow almost infinite-step regulation from part of one cylinder to full-load on 40 cylinders.

The Six Lakes station takes from the pipeline whatever amount of gas is not currently needed by the Detroit area, and stores it underground for use when winter's demands exceed the pipeline capacity. By its nature, this type of service means that the compressors must be able to handle any load from a mere trickle to millions of cubic feet per day. Also, since the pressure of the storage field varies with the amount of gas in it, the compressors must be extremely versatile to handle many different pressures as well as fluctuating capacities.

At this station, different combinations of the nine 2000-hp and two 1000-hp Ingersoll-Rand KVS compressors may be used to provide 20 load steps in 1000-hp increments even with all cylinders loaded. The capacity of each cylinder of each machine can also be controlled in four steps by a unique method which I-R developed for this service.

In addition to this outstanding flexibility, there is easy speed control without sacrifice of gas and oil economy—another Ingersoll-Rand 4-cycle characteristic.

Also at the Six Lakes station, three 408-hp Ingersoll-Rand 4-cycle, V-angle PSVG gas-engine-generators supply all A-C power. Starting air for both the KVS compressors and the power units is supplied by two Ingersoll-Rand ES compressors—one with electric drive, and a standby unit equipped with gasoline-engine drive.

The exact compressor and power requirements for *any* pipeline application can be met with dependable, time-proven Ingersoll-Rand 4-cycle, V-angle engine equipment. Your I-R representative will be glad to give you complete information. Call or write now.

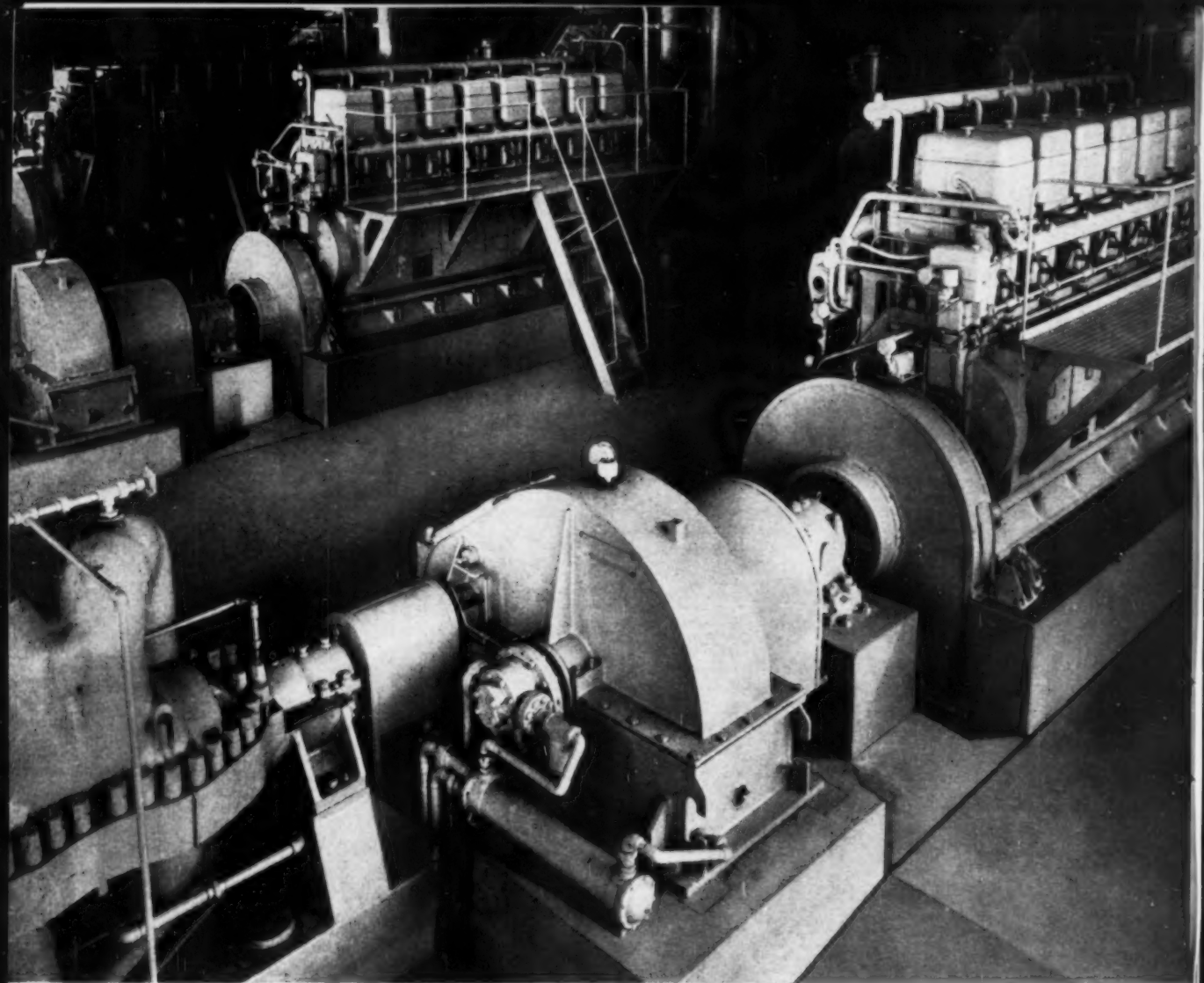
Only IR compressors have CHANNEL VALVES

Known for high efficiency, quiet operation and exceptional durability. Entirely different. Each valve is a combination of straight-lifting stainless-steel channels and leaf springs, with trapped-air spaces which cushion action, prevent impact.

Ingersoll-Rand 4-CYCLE

6-712 **11 Broadway, New York 4, N.Y.**

COMPRESSORS · GAS & DIESEL ENGINES · PUMPS · AIR & ELECTRIC TOOLS · CONDENSERS · VACUUM EQUIPMENT · ROCK DRILLS



0459

Pipe line engines by Nordberg

Unattended, remote control operation of six Nordberg engine-pumping units is an important feature of the Evangeline Products Pipe Line System. Three Nordberg 1720 horsepower, four-cycle engines are installed in two identical, full satellite pumping stations on the 16-inch products line.

NORDBERG MANUFACTURING COMPANY
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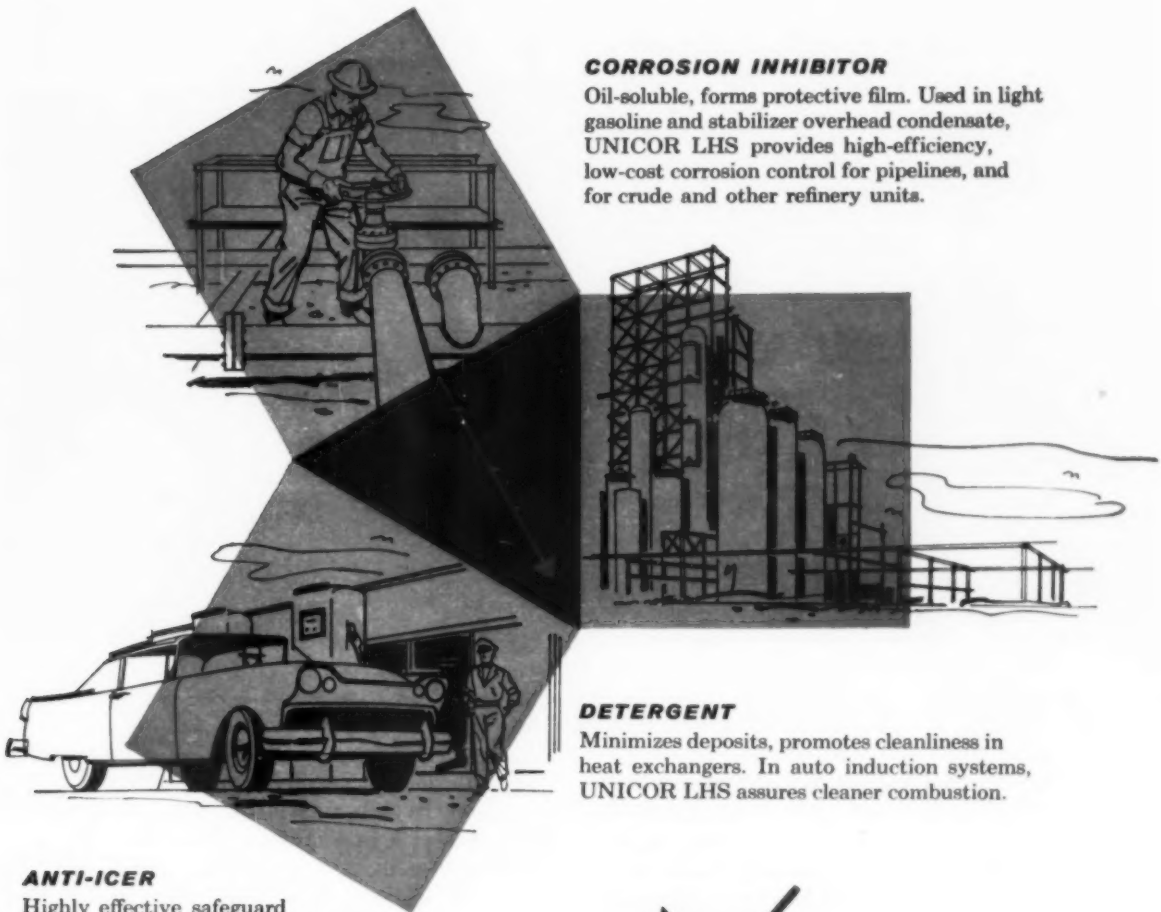

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NEW!

W-K-M's *Pressure Sealing* GATE VALVE

THIS BOLD ADVANCE IN VALVE DESIGN

Assures:

- ***Positive Seal***
- ***Efficient Operation***
- ***Superior Performance***

Floating Seats Give Perfect Seal. Each seat in W-K-M's *Pressure Sealing* Gate Valve consists of two kinds of rubber, formulated to W-K-M's specifications, molded to a hardened steel insert. There is a full bore opening, the same diameter as the port, through the insert.

Soft rubber, for sealing, is on the back side of each seat. Tougher, abrasive-resistant rubber is on the front or gate side. The steel insert is ringed with holes. Pressure forces the soft rubber through these holes, reinforcing the tough rubber and compensating for any wear.

Line Pressure Seals the Seats. In the closed position, the gate forms a primary seal with the raised ring of tough, firm rubber on the the face of each seat. As the line pressure is applied to the valve, the gate is forced against the rubber ring on the downstream seat and compresses it until the gate rests against the hardened steel insert. This provides a tight seal between the gate and the rubber on the face of the seat, and a secondary metal-to-metal seal. The action also forces the soft rubber on the back of the seat tightly into its recess and prevents any downstream flow at this point. The result: a bubble-tight downstream seal.

The upstream seal is caused by line pressure forcing its way into the seat recess behind the upstream seat, moving it against the gate. This pressure is sufficient to achieve a positive seal between the gate and the ring of tough rubber on the face of the seat. At the same time, the raised rim of soft rubber on the back of the seat forms a tight seal with the seat recess.

These double-action floating seats provide tight, positive seals – both upstream and downstream.

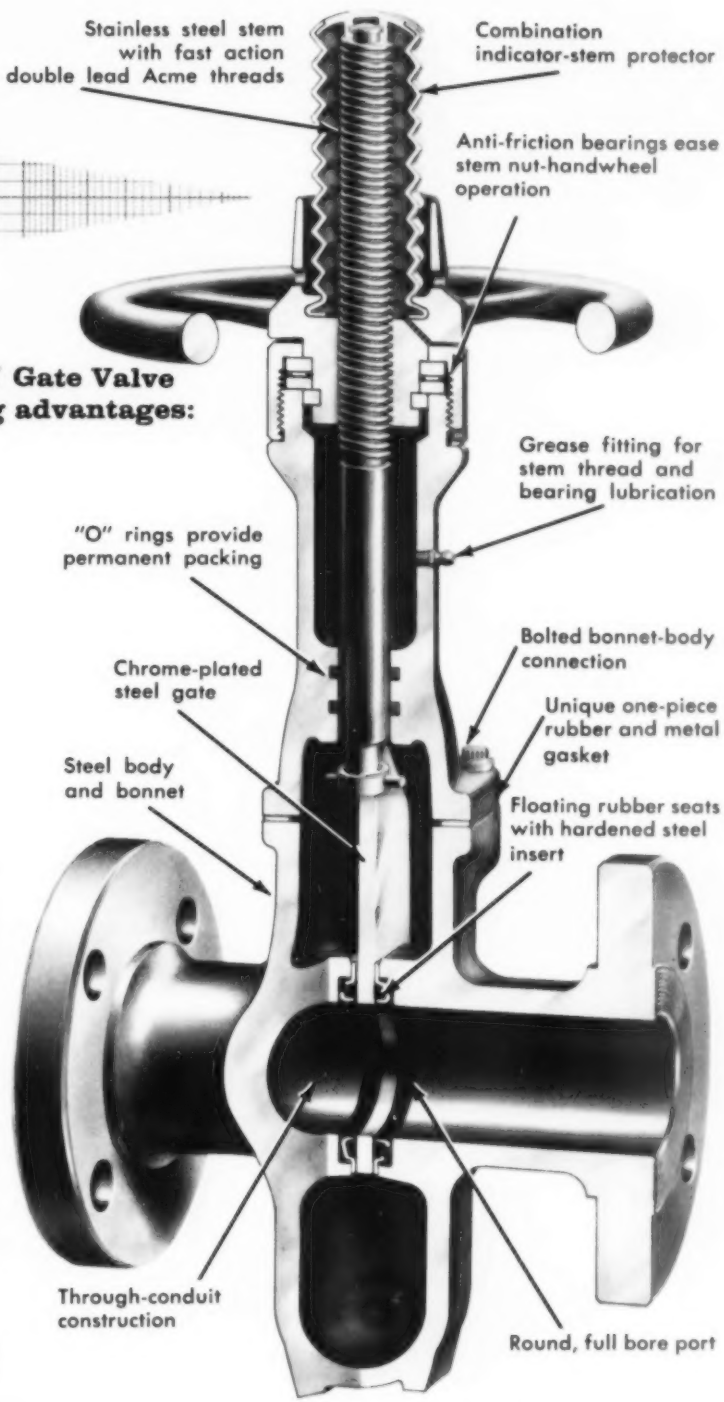
Change Seats in Minutes – On the Line! You can change the seats in W-K-M's *Pressure Sealing* Gate Valve *on the line*. The only tools needed are a wrench to loosen the body bolts, and a pair of pliers.

Important Safety Feature: This valve has been designed to automatically relieve excessive body pressure caused by thermal expansion. The excess pressure forces the upstream seat away from the gate, allowing it to bleed into the line.

Additional Advantages: The full bore, through-conduit gate construction provides a perfectly smooth bore through the valve, eliminating pockets or cavities in which foreign matter might accumulate. Result: perfectly smooth flow with no more turbulence or pressure drop than through an equal length of pipe.

W-K-M's *Pressure Sealing* Gate Valve is a two-way valve and may be installed with the pressure on either side. It is especially well suited for block and bleed service since it seals positively both upstream and downstream. The body may be bled of pressure with the gate in either the fully open or fully closed position.

ANOTHER OUTSTANDING PRODUCT OF **W-K-M's** *Creative Engineering*


Stainless steel stem with fast action double lead Acme threads
Combination indicator-stem protector
Anti-friction bearings ease stem nut-handwheel operation
Grease fitting for stem thread and bearing lubrication
"O" rings provide permanent packing
Bolted bonnet-body connection
Chrome-plated steel gate
Unique one-piece rubber and metal gasket
Steel body and bonnet
Floating rubber seats with hardened steel insert
Through-conduit construction
Round, full bore port

W-K-M's *Pressure Sealing* Gate Valve gives you all these operating advantages:

- **Tight seal both up and downstream in open and closed position**
- **Full bore, through-conduit**
- **Seats fully protected from abrasive action of lading**
- **Non-lubricated**
- **Seats automatically adjust for wear**
- **Automatic relief of excessive body pressure**
- **Ideal for abrasive ladings, light gases, volatile liquids up to 250° F.**
- **Easy to overhaul on the line**

Tested and Proved in the Toughest Services. Enthusiastic, completely favorable user reports affirm the superior quality and effortless operation of W-K-M's new *Pressure Sealing* Gate Valve. "Handles all the sludge in a gas blowout line easily — works better than any valve we've used," states a petroleum engineer. A foreman says, " . . . easiest operating valve I ever saw . . . smoothest working valve made." Similar reports covering many other services are in W-K-M's engineering test data files.

One of the Most Versatile Valves Ever Produced. W-K-M's *Pressure Sealing* Gate Valve is extremely versatile — can handle almost any low pressure job. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ASA 150 lb. (275 cwp) and ASA 300 lb. (720 cwp)

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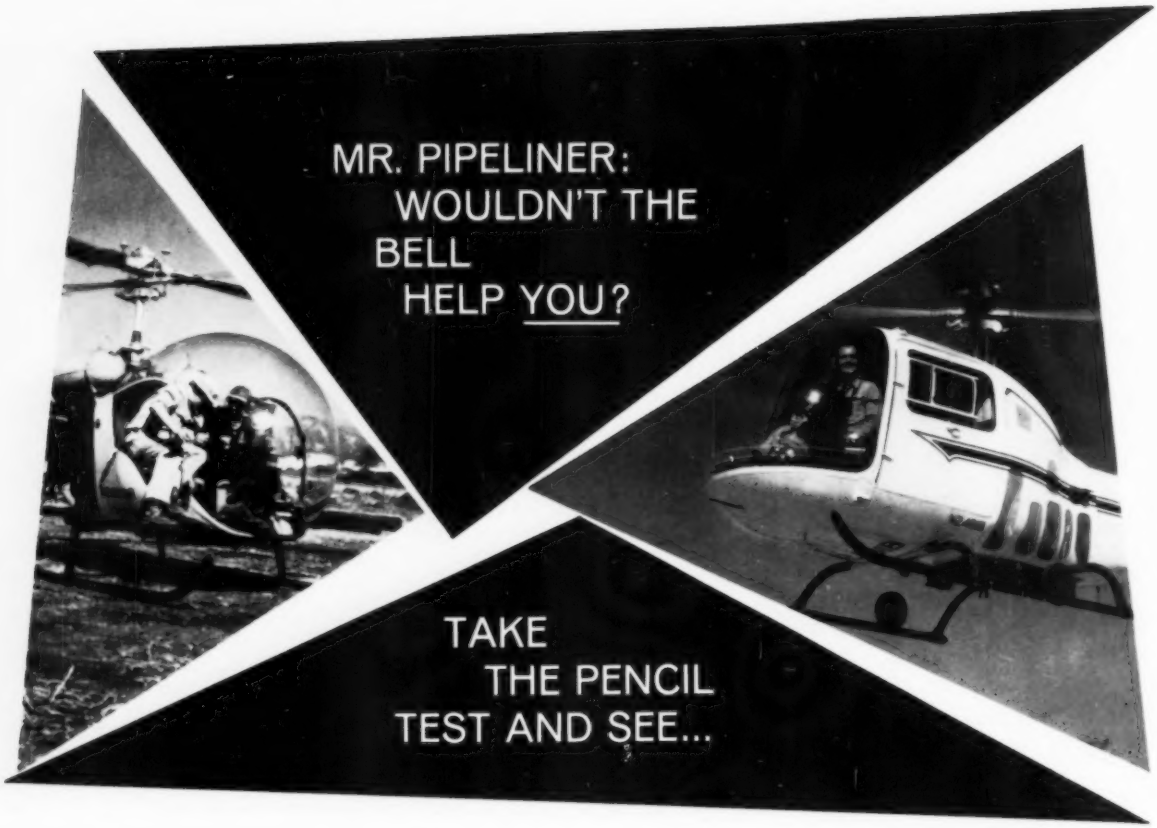

How does a pipeline man use his Bell helicopter? For some time we've been gathering operational data from Bell users. Among it are striking cases of how imaginative contractors make big capital out of a versatile machine. But these are frosting on the cake. The "cake" itself is the Bell's ability to start for you, today . . perform half a dozen basic jobs . . improve efficiency and save you money in the bargain. To see what we mean, answer these questions. Then ask yourself . . isn't it time to try a Bell now?

YES	NO	
☐	☐	Could we sharpen up our contract bids (and eliminate errors in surveying) by getting a closer look at the proposed right of way?
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☐	☐	Would it save costly supervisory time if we could get inspectors *quickly* to any spot along the right of way?
☐	☐	Ever consider the morale factor of having instant air-ambulance service to any job site in the wilderness?
☐	☐	Could we impress more prospects by showing them our work-in-progress, from the air and at close range?
☐	☐	Do our estimators know that Charter Helicopter Service is easily available for trial and experimentation?

Now tear out just the test portion of this page and send with your name, title, company and address to: Department 35H, Bell Helicopter Corporation, Fort Worth, Texas. We'll send you additional information about the Bell's role in Construction and Utilities.

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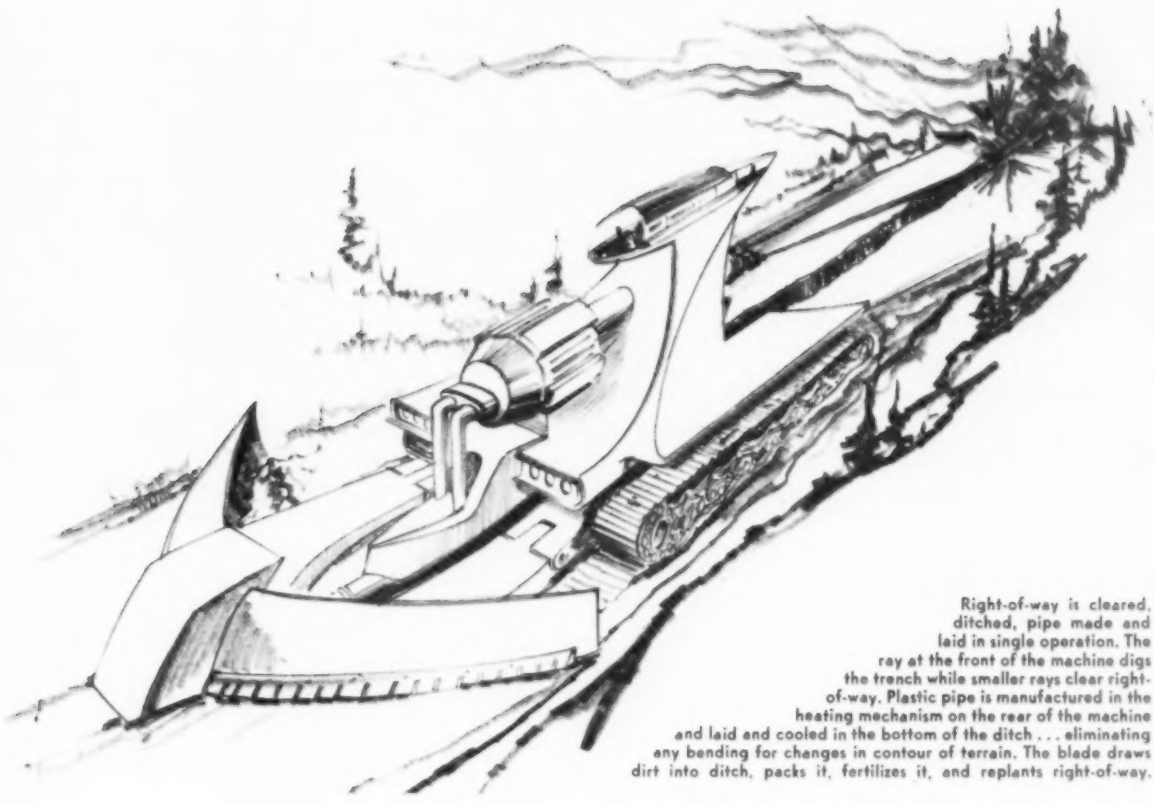


Right-of-way is cleared, ditched, pipe made and laid in single operation. The ray at the front of the machine digs the trench while smaller rays clear right-of-way. Plastic pipe is manufactured in the heating mechanism on the rear of the machine and laid and cooled in the bottom of the ditch . . . eliminating any bending for changes in contour of terrain. The blade draws dirt into ditch, packs it, fertilizes it, and replants right-of-way.

THE CENTURY AHEAD

■ Everlasting Pipe . . . Infra-red Welding . . . Machine Makes Pipe, Ditches, Backfills

Wilson N. Gilliat
Assistant Vice President-Engineering
Williams Brothers Company

MANY HEADS are better than one on such a crystal-gazing subject as a 100-year projection of pipeline developments. Thus at Williams Brothers, pipeliners for 50 years, we asked for contributions from several of our engineers. Even one of our secretaries insisted on getting in on the act.

This article represents a tongue-in-cheek compilation of the many ideas submitted — some technical, and some completely out of this world as we know it now. Paragraphs are datelined as new releases in an attempt to provide interesting, and we hope, provocative reading.

New Pipe Combines Plastic and Steel, Joints Welded by Infra-red Process

March 7, 1965 — The American Petroleum Institute recently authorized the use of Monocoat Pipe — developed through the research cooperation of the steel and plastic coating industries. The tough plastic exterior and interior coatings, each 24 mils in thickness, are literally "baked on" the pipe monolithically as it passes through a final heat at the mill.

Since pipe ends are no longer bevelled due to the recent advent of the automatic infra-red and ultra-high-frequency field welding techniques, the coating at field joints fuses together during the welding process.

The resulting pipelines are expected to have practically infinite useful life completely free of corrosive attack. Research was accelerated last year to provide swift competition for the new corrosion-free alumalloy pipe developed by the Baker-Aktiengesellschaft syndicate.

Pipelayer Makes Pipe, Ditches, Backfills at 15 Miles Per Day

November 9, 1967 — A 274-mile network of irrigation pipelines, from 6 to 12 in. in diam has just been completed south of Cairo, Egypt, by an ingenious pipeline machine developed in Germany. Coils of plate 7 ft wide and 12 ft in diam were fed into the mobile pipelayer, which progressed along the right-of-way at 15 miles per day. The pipelayer ditches and backfills as well as fabricates the

THE CENTURY AHEAD

Pipeline suspended in nuclear magnetic field. These fan-shaped magnets direct a field of magnetic repelling forces that hold the pipeline in suspension from one sub-station to the next. The small magnet in the center exerts a pulling force on the pipe and holds it in the field of the large outlying magnets.

non-corrosive pipe from the plate at the same rate as forward travel of the machine.

The continuous spiral butt-weld is accomplished with 100 percent joint efficiency by instantaneous ultra-high-frequency induction. A special welding attachment joins the V-notched ends of plate coils so that little time is lost in changing coil reels. The pipelaying method is particularly economical where freight of prefabricated pipe is excessive due to the length of haul and ratio of weight vs space occupied involved.

Flexible Plastic Pipeline Laid Across the Straits of Gibraltar

July 19, 1969 — Williams Brothers Company (plug) has just completed the laying of a flexible plastic pipeline across the Straits of Gibraltar. The 36-in. line is soon to be tied in to the section from Morocco gas fields to serve the 36-in. pipeline to Madrid and Paris with 890,000,000 cu ft per day.

The pipe, of 1.26-in. wall thickness, was manufactured continuously by a spiral extrusion process on the laying barge. Powdered neoprenethylic resin was towed in drums behind the lay-ship, and constantly fed automatically by forced-draft suction line into a giant hopper on the lay-ship deck. Here the powder is dissolved in Quickset, the recently developed mineral lacquer that is extracted by a fuel cell reaction from sea water. As the pipe is extruded from the hopper base, high-tensile coiled wire is spiraled through the hardening plastic pipe to help resist the crushing hydrostatic pressure on the ocean floor.

Line Pipe of 180,000 Psi Yield Strength in Full Production

September 24, 1973 — North American Steel today announced full-scale production of its new Hi-Y line pipe, with a yield strength of 180,000 psi. The pipe is the result of a perfected cold-drawn process, similar to that used for extruding high-tensile wire for many years. Diameters up to 72 in. are normally to be available.

Wilson N. Gilliat

graduated with a BS degree in civil engineering from Massachusetts Institute of Technology in 1944. He served as naval officer and instructor at the U. S. Naval Academy, 1944-46, and was assistant to the chief engineer of Great Lakes Pipe Line Company, 1947-50. He has been employed as hydraulic design study and field engineer on service systems, refinery, petrochemical, and pipeline projects with leading engineering companies. Joined Williams Brothers Company in 1954 as project engineer for economic studies and engineering development. He was appointed chief engineer in 1956 and assistant vice president — engineering in 1957.

U-269 Fuel Cells Used as Turbine Power on New 60-in. Products Line

December 1, 1974 — The Atomic Energy Commission approved the use of U-269 fuel cells as turbine power for the Trans-State Pipeline pumping stations. Trans-State's announced plans to build the 60-in. products line using the newly developed Hi-Y pipe were contingent upon nuclear power. This power, in conjunction with completely automatic unattended station operation, effects such minimum station operating costs that high-pressure operation, up to 2800 psi, is economically feasible.

Midwest Dairy Products Pipeline To Utilize "Core-Annulus" Method

February 29, 1976 — The Minnesota-Wisconsin Dairy Association has announced plans to construct a pipeline from the Minneapolis area to St. Louis to transport butter and cheese. The dairy products with viscosities up to 100,000 SSU will be shipped by the "core-annulus" method, long used for pipelining viscous crude oils. The highly viscous product is to be separated from the pipe wall by a ring of deoxygenated milk, also for St. Louis consumption.

The various cheeses will be batched through the pipeline together with butter, and automatically packed at the St. Louis terminus in a vacuum trap attached to the pipeline, thus excluding commingling of products with air before ultimate consumption.

These plans are the result of successful operation of other foodstuff pipelines operating between producer and consumer areas, now transporting ketchup, molasses, mayonnaise, fruit and vegetable juices, etc.

Capsuled Freight Shipped Through Underground Twin Pneumatic Tubes

October 21, 2014 — Alliance Freight Company today extended service of their 8-ft diam freight pipeline from Oklahoma City to St. Louis. The original section generally following the old Highway 66 right-of-way from Los Angeles has been in successful service for four years. Freight capsules in the twin pneumatic tubes can now travel the 1750-mile traverse in 14 hours, with 27 intermediate exit airlocks. The passenger vehicle freeway over the tubes is open to Springfield, Missouri, with completion to St. Louis due in three months.

Pipeline Suspended in Nuclear Magnetic Field Is Proposed

April 16, 2031 — The World Pipeline Committee of the UNPI is considering a novel proposal by a Russian scientist. Where advantageous to avoid congestion, future pipelines can be suspended in air at any desired elevation up to 20 ft above ground. A nuclear magnetic field, controlled from the ground bed and pipe conductor, regulates the height, which can be altered in any section for maintenance or clearance purposes. The plan promises an end to right-of-way problems where economically warranted.

Sahara Desert Now a Veritable Paradise Thanks to Water Line

May 4, 2036 — Canal construction in the Sahara Desert has doubled during the last year, according to recently published reports. The terrain is ideally suited for canal systems, and with the advent of an abundant water supply, farming and industry alike have flourished to the point where a better transportation network is required. The water supply, of course, is the result of the large diameter pipelines from the Atlantic Ocean constructed by Williams Brothers Company of Tulsa, Oklahoma, (second plug) some few years ago. Since their installation, the low-cost nuclear-powered pump stations have operated continuously to transform this once arid region into a veritable paradise.

Pipelines Play Part in Population Shift as 500-Million Mark Is Passed

January 13, 2059 — The population of the United States clicked past the 500-million mark today, according to the Census Bureau's electronic brain. Greatest increase since the year 2000 has occurred in Nevada, now considered the vegetable and fruit center of the country. Old-timers are hard-pressed to remember the "desert days" before the sequential construction of the three aqueducts, 15 to 24-ft diam pipelines, and ancillary distribution networks flooding the State with converted Pacific sea water.

Pipeline Express – New Era Dawns In Passenger Transportation

June 15, 2059 — A new era of public transportation dawned recently with the opening of the New York City to Washington pipeline express. With all the technological advance in air and space travel during the last quarter century, none can compare with this new system of public transportation.

Traveling can now be as pleasant as sitting on a sofa at home; and safer. The air cushion which separates each car prevents any collisions or accidents. The view through the tinted plastic pipe is breath-taking and the route was carefully selected to take advantage of the beautiful countryside.

Actually the plastic pipe is used only on the above-ground sections of the line with steel pipe being used on all underground sections and reinforced rubber-like pipe under rivers.

Low-cost nuclear-powered compressor stations supply the vacuum required for normal operation. These stations are located along and at the terminus of the system. The high-strength tinted plastic pipe was extruded on the site during construction to reduce cost and adapt to the varied terrain. This pipe is completely fireproof and very hard, enabling it to resist the abrasions caused by the cars as they whiz along.

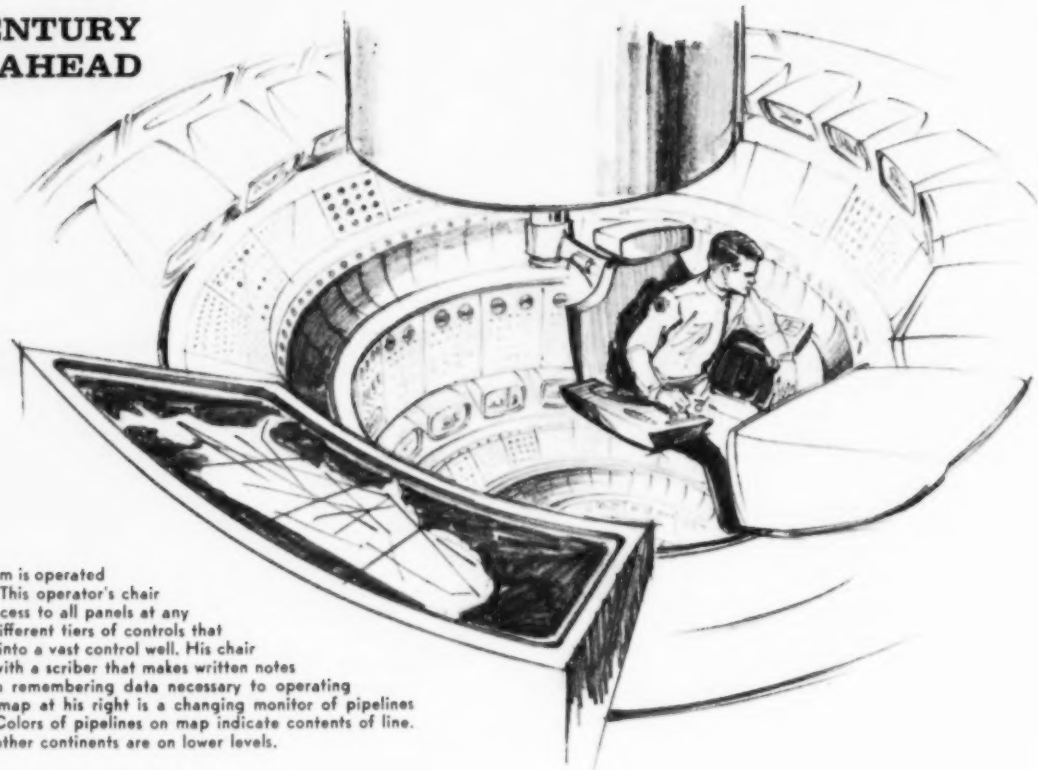
The tremendous capacity of the pipeline express, 500,000 passengers per hour, will only be required in the case of extreme emergency. In connection with this, the National Defense Agency has requested that all major cities install two or more systems to be used for evacuation in the event of an enemy nuclear attack.

The low cost, speed (over 100 mph), comfort, and ease of construction of the new express system is destined to attract many users.

Acknowledgment

This article was adapted from the suggestions of C. M. Collins, V. E. Butler, F. E. Culvern, J. E. Donnigan, E. E. Mincheff, and Mrs. Jo Hooker, all affiliated with the Williams Brothers Engineering Department, Tulsa, Oklahoma. ■

THE CENTURY AHEAD



Pipeline system is operated by one man. This operator's chair swivels for access to all panels at any level in the different tiers of controls that extend down into a vast control well. His chair is equipped with a scriber that makes written notes for his use in remembering data necessary to operating control. The map at his right is a changing monitor of pipelines in the U. S. Colors of pipelines on map indicate contents of line. Monitors of other continents are on lower levels.

■ One-Man System Operation . . . Pushbutton Construction

R. C. Hunt,
Gas Engineer
Ebasco Services Incorporated

A LOOK at the expected growth and development of pipelines over the next 100 years reveals some interesting possibilities. The present greatest use of pipelines is the transportation of various energy fuels. Future growth, therefore, will depend on demand for the types of energy that can be transported most feasibly through pipelines. From examination of several forecasts of energy it is seen that the requirements of this country are expected to double in the next 25 years.

At present a little more than 30 percent of all energy used in the United States is transported by pipeline. Developments and change in type of energy used in 25 or 100 years either can increase or decrease this percentage. Economic development of atomic energy will have the greatest effect on development of future energy from fossil fuels. But the use of atomic energy is not expected to affect the pipeline outlook for the next 25 years.

Present fossil fuels may be broken down and the structure rearranged to new forms of the so-called exotic fuels or free radicals. This would permit transportation of more energy through smaller facilities.

Some transmission companies in the near future may reverse the present trend of field removal of liquid hydrocarbons and transport rich gas. Removal of the liquids would be at point of use.

Probably the greatest challenge at the present is the development of cheaper methods and materials for laying pipelines across large and deep bodies of water.

Possibly pipelines will be developed for the transportation of grain, ore, or materials used in manufacturing processes. At the present time the possibilities of transporting wood pulp to paper mills is being studied. There will probably also be a number of pipelines built from tidewater to transport treated sea water to the arid areas in the southwest. These uses probably will account for a small percentage of future pipelines.

Minimum yield strength of pipe, which has now moved up to 56,000 psi, can be expected to move on up to 70,000 or 80,000 psi in the next few years. Yield will probably have reached 100,000 psi by the time the development of plastic pipe overtakes steel pipe for use in large pipelines. Pipelines in 2059 will be constructed of some type of plastic, corrosion-resistant material.

Diameters of the lines will increase more slowly than the yield strength of the steel used. Operating pressure may not increase greatly over the present design because of pressure limitations that may be imposed by state or county governments.

One-Man System Operation

The present trend toward the complete automation of pipelines, compressor stations, and meter stations will be

culminated in the next century. The use of automatic controls and equipment to monitor the controls, and equipment to monitor the monitors will be expanded until a pipeline system will be operated by one man. This man will merely keep the master controller in operation and direct maintenance of other equipment. Cost of operation will decrease and cost of maintenance will increase.

Gas Flow Controlled By Computers

The flow of gas through pipelines will be controlled by computer, which receives its data from automatic weather forecasters at various points of use. Flow from wells to the ultimate consumer will be scheduled completely by machine. Probably all pipeline systems will be interconnected much as the electric systems are today.

Oil and product lines will be integrally controlled from well to refinery based on demand for finished products. A master computer using a large number of factors will forecast demand by various areas and control the entire productive system.

Pipe from Skelp on Right-of-Way

Changes in the construction of pipelines will evolve slowly. Probably among the first of the major changes will be the development of an economical and practical automatic welder that can be transported on the right-of-way. This would still require a pipe gang and tie-in gangs, but would eliminate most of the hand welding, which is now a major cost of construction.

With the development of portable welding equipment it might be possible to fabricate small pipe from skelp on the right-of-way and eliminate some of the circumferential welds.

X-ray inspection of welding will be replaced by sonic inspection sometime in the future.

Protective coatings are now in process of changing more toward the use of a material that requires less equipment to apply and allows more uniformity of application. Future steel lines may be bare and completely protected cathodically.

Equipment for the construction of these larger and heavy pipelines will pose no more problem than the transition from construction of 20-in. line to 36-in. line. Equipment will be developed and built as it is needed.

Pushbutton Construction

If pipelines are still being constructed in 2059 they will probably be built by men pushing buttons riding in air conditioned machines.

THE CENTURY AHEAD

R. C. Hunt

Employed as a gas engineer in the Consulting Engineering Department of Ebasco Services Incorporated, New York City, and is engaged in the design and supervision of construction of pipelines. He received his degree in engineering in 1940 and since World War II has been employed by Texas Eastern Transmission Corporation and other pipeline companies, performing various duties in design, construction, and operation.

The right-of-way will be cleared by equipment that reduces the trees and brush to ashes and leaves it to be mixed with the backfill. The right-of-way will be cleared to minimum width required by the machines used to lay pipe. The ditch will be opened continuously just ahead of the pipelaying machine. Sonic energy will be used to disintegrate any rock or obstructions encountered in the ditch line.

Traveling Pipe-Making Machine . . .

Pipe will be of a plastic material and formed by a traveling pipemaking machine. The major part of the material used to make the pipe will be pumped to the machine through the pipeline being laid, so that pipe stringing and hauling on the right-of-way will be eliminated.

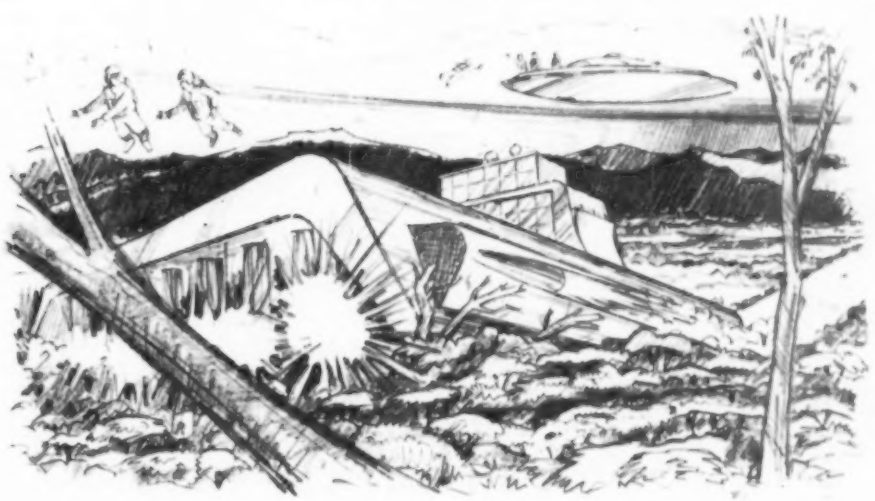
The pipe will be extruded and lowered into the ditch by the same machine. The ditch will be closed immediately behind the pipelaying machine. Work will be on a 24-hr round-the-clock schedule.

. . . Airborne by Air Jets

These machines to perform the operations in constructing the line will be carried on low pressure rollers or airborne a few inches off the ground by air jets.

Surveying and location will be accomplished with aerial photography without sending a surveyor on the ground. The location will be furnished the guiding mechanisms of the machines, which will keep them on the predetermined center line.

It is certain, however, that between now and 2059 one thing won't change. The poor pipeline engineer will still get the cussing for anything that goes wrong on the job. ■



Right-of-way being cleared by equipment that reduces trees and brush to ashes and leaves it to be mixed with backfill . . . opens the ditch continuously just ahead of the pipelayer.

THE CENTURY AHEAD

This device, remotely controlled, is being pulled through the ground at pipeline depth, fusing the surrounding soil into a cylinder of the desired diameter. The conduit or pipeline thus formed can be used for transporting many materials.

■ Changes in Pipelining Will Come Faster and Be More Drastic

L. F. Scherer
Assistant General Manager
The Texas Pipe Line Company

AS WE ARE all aware, pipelines and their operation have changed drastically in the last 12 years; but I actually believe the changes possible in the next ten years are even greater, and to try to extend that to 100 years would be pure fantasy.

The changes have not all been due to automation or special controls, but have been largely due to improved materials of construction, improved mechanical construction equipment, and, of course, major improvements in controls, instruments, and electronics. These, together with imagination and engineering know-how and a willingness to break from the past, have made the change possible.

Lease to Consumer Automatically

We believe that within the next ten years we can well expect to see pipeline systems so designed and operated as to gather oil from the field lease, check it through central points, dispatch it, and deliver crude and products at distant points all automatically by the use of punch cards or programmed tapes and with the minimum in personnel. Materials, devices, and controls are available at present to do exactly this and all that is lacking is the opportunity and imagination to apply it to a complete system. Most of the components necessary already have been applied in individual sections or operations.

A Special Steel for Line Pipe . . .

Present methods for laying pipelines are becoming extremely unwieldy and expensive, labor and equipment costs now being almost as much as the cost of the material. We can, therefore, anticipate rather drastic changes in this regard. We already are using much lighter and tougher grades of steel for line pipe, and with the development of some of the new synthetic resins, and newer ones to come, which will permit coating both the inside and the outside of a high tensile, thin wall pipe with a high grade dielectric material to prevent corrosion, we can anticipate the development of such a steel along with improved techniques for field welding of joints.

Double jointing will be improved, and with lighter steel, perhaps even longer field sections will be possible. Manual welding of field joints will be eliminated, thus reducing costs and giving more uniform butt welds in this special steel.

. . . or a Synthetic Tube?

As a matter of fact, there is good reason to believe that the development of resins together with suitable reinforcements can, within the next few years, result in the develop-

L. F. Scherer

Received his BS degree in mechanical engineering from the University of Illinois in 1925, and for three years thereafter was engaged in design and development work with Fairbanks, Morse and Company in the diesel engine division. He then joined The Texas Pipe Line Company and worked with the engineering, designing, and construction of pipelines. During World War II he was with War Emergency Pipelines as a special design engineer, station construction superintendent, and chief engineer.

In 1944, Scherer designed and had charge of construction of a crude oil pipeline for navy service in California. Returning to The Texas Pipe Line Company in 1945, he was appointed chief engineer and has been actively engaged in the design and construction of that company's enlarged modern facilities. In June 1951 he was appointed assistant general manager of The Texas Pipe Line Company and Texas-New Mexico Pipe Line Company and is a director in both companies.

ment of a pipeline material sufficiently strong and resistant to chemicals and elements which, if manufactured in quantity, can result in the displacement of steel pipe for many applications. There is even good reason to think that such a material could be manufactured and produced by equipment traveling on the right-of-way and extruding the finished pipeline as a tubing directly into the ditch.

Soil Fused Into a Cylinder

To take a real Jules Verne look at this proposition, it is conceivable that a suitable tool could be developed that would plow this synthetic tube directly into a ditch much as large diameter telephone cable is now plowed into the ground without opening a ditch.

To carry this just a step further, it is quite conceivable that a device could be pulled through the ground at pipeline depth that would actually fuse the surrounding soil into a cylinder of the desired diameter which could be used as a conduit or pipeline for handling many materials. Admittedly, this sounds a bit wild right now, at least to the layman, but it is not an unreasonable possibility in light of the chemical knowledge and sources of high energy and heat now available.

Movement by New Electronic Principles

We are rapidly reaching the ultimate in sources of power for moving fluids and gases through pipelines, although admittedly, many of the devices we now use can still be improved; and some that are being developed can be developed further and made more applicable. I do not know whether it will be possible in the next 100 years to get away from present types of power developers or not, but it would seem quite possible that the movement of fluids and gases through pipelines could be accomplished by the application of electronic forces and principles now only dreamed of. The transmission of electrical energy without wires or connection of any kind between source and use is now entirely feasible and there is no reason to believe that this same principle cannot be applied to develop energy or applying energy in transit.

THE CENTURY AHEAD

Shipment of Many Products Possible

We believe also that the uses to which pipelines will be put in the future will be expanded. There seems to be no good reason why any loose bulk material susceptible to displacement, either hydraulically, pneumatically, or through the use of some electronic force not now available, cannot be moved through a pipeline provided, of course, that it is available in sufficient quantity to warrant economic transportation. Included in this category would be some of the more common bulk chemicals capable of being placed in solution or held in suspension in an air-gas system. Wood chips, pulp materials, asbestos fibers, cement, and a host of other materials also could be considered as subject to transportation by pipeline.

We are all reasonably familiar with the package or ticket delivery system used by many office buildings, department stores, and the Post Office Department for pneumatic delivery of containers to remote locations. It is therefore not too impractical to consider that pipelines, being buried and not interfering with the surface use of the soil, could be utilized for the long distance transportation of properly packaged materials in a gas or even in a fluid stream. Certainly, as the traffic on even our newly proposed highways increases, as we know it will, such a means of transportation freeing highways of this type of uniform load could have possibilities.

The above imagery or prognostication should give you, if nothing more, something to laugh at; however, as a youth, I was very fond of reading Jules Verne and I have lived long enough to see most of his wild dreams become practical devices, so I no longer discredit the so-called wild dreams of the future. ■

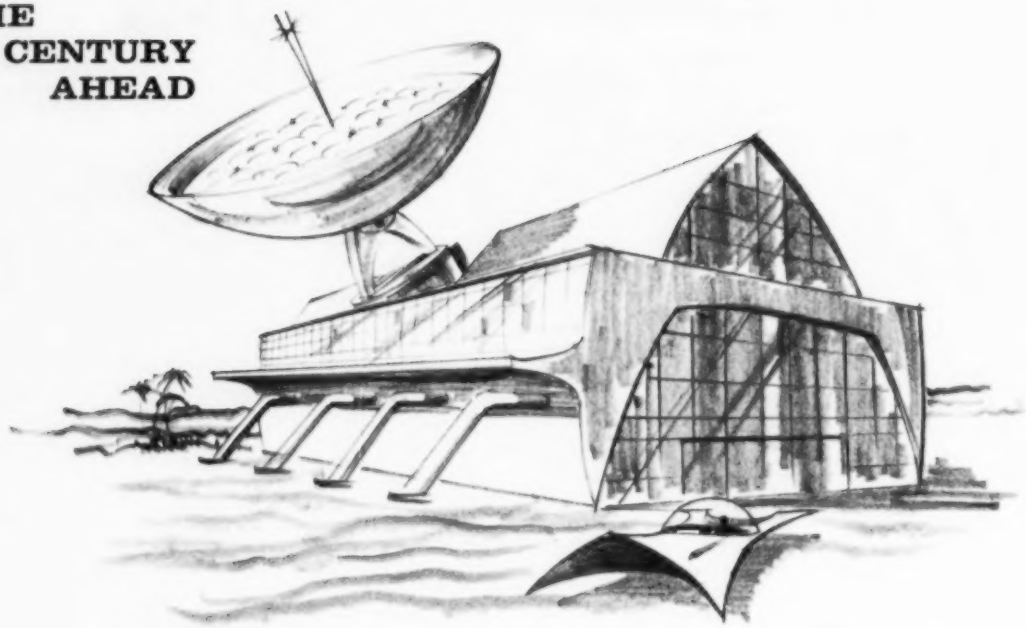
Potential Future Developments

J. E. Green, *Manager*
Technical Services Department
Shell Pipe Line Corporation

Here are a few subjects that are considered by Shell to have potential for future significant developments:

1. Development of a thin, tough, and flexible pipe coating to be applied at the mill. The coating so durable that the pipe may be handled and laid as if it were bare.
2. Development and use of extremely high speed centrifugal pumps (for use especially, directly connected to combustion turbines).
3. Developments in the technique of transporting extremely viscous oils without heating.
4. Design of completely mechanized, centrally controlled pipeline (the commonly referred to computer controlled line).

THE CENTURY AHEAD



Solar energy provides power to drive pumping equipment . . . this gigantic attractor automatically swivels in any direction to catch the greatest amount of the sun's rays at any time of day.

■ The Great Grid–2059 A.D.– Trans-America Pipeline Saves Nation

N. H. McAfee,
Interprovincial Pipe Line Company

FOLLOWING THE POPULATION EXPLOSION of the 1990's and the tremendous resettlement of impoverished peoples at the turn of the century, there was no further opposition to the Trans America Pipeline System.

Even its one-time opponents could see that what they had labelled a grandiose dream was now an essential to survival. The prairies, plains, and deserts of North America were filled with new communities. While relief shipments could sustain them on a short term basis, it was essential that the land itself produce enough food. The arid lands needed water. The plan of the Trans America system was to provide water by means of two gigantic pipelines — one from the Pacific Ocean, the other from the Great Lakes.

Tau Line Pipe the Key

Such a scheme would have been impossible had not the crash program of 2004 produced Tau. Tau, with its molecular structure giving characteristics of steel and plastic, opened up a new era of pipeline progress. It could be extruded in any diameter. It was impervious to heat, cold, impact, and corrosion, yet light and easily handled. For Trans Am it was the solution to many of the problems posed by the concept of transferring water to inland prairies and deserts.

It was early spring in the year 2007 that the two largest pipeline forces ever assembled started work on the two branches of Trans Am. There were no public ceremonies, flags or speeches — just the roar of specialized equipment moving off from the Pacific Ocean and the Great Lakes to produce the first of the gigantic grids that eventually would lace across the face of North America like a fisherman's net.

Disintegrators Clear Right-of-Way

Thanks to the peculiar qualities of Tau pipe, the work proceeded at a rapid rate. The pipe was extruded and laid above ground without ditching or other protection.

In place of the traditional bushing and clearing crews, twin disintegrators mounted on the extruders levelled a clear strip 200 ft wide. The extruders rolled across the landscape leaving behind the largest diameter pipe ever laid.

By agreement between the two governments, a straight line right-of-way had been set aside for the project. The edges of the strip were marked by ray towers, which provided both protection from wandering livestock and a warning system of any break in the line itself.

In addition to the giant pipe a servicing monorail system was put down in the same 200 ft strip.

The three great companies that had pooled brains and resources to produce the basic plan for Trans Am had looked ahead to the time when full use would be made of this vital right-of-way. The great water pipe had not been put into operation before additional lines of pipe were being laid along the right-of-way. These, together with the G-Power lines, made up the first of the great grids.

Disintegrating machine floats on pillars of air from fan-type blades. Its center directional vibrator is amplified by the six surrounding vibrators and reaches frequencies necessary to shatter rock formations.

Special Cutting and Repair Tool

A revolutionary change in pipeline methods was brought about by the use of Tau pipe. The pipeliners discarded the sputtering arc and now used the special Tau cutting and repair tool. With it, take-off points could be cut out in a matter of seconds. By reversing the tool, repairs and tie-in welds were made by molecular marriage.

The success of the great grid is now history. With its network of delivery lines it provided the essential water to turn the barren lands into the most extensively cultivated area of land in the world. The salt water of the Pacific, which many had feared would be of no value for irrigation, became a doubly valuable source of life to the southern districts. The new extractive units, which were put in service at each delivery point, not only removed the injurious salt, but produced a multitude of chemicals, which were refined on the spot into fertilizer. This new fertilizer extended the possible yield of each irrigated acre ten-fold and, eventually, was the deciding factor in the battle for food production.

Once the basic needs of the vast population had been met, the further advantages of the pipeline grid became obvious. Additional lines carried natural gas, crude oil, petroleum products, and, depending on local supplies, raw materials such as pulverized coal, wood chips, and a large variety of ores.

N. H. McAfee

public relations adviser in the department of employee and public relations of the Interprovincial Pipe Line Company.

A graduate of the University of Alberta, McAfee was engaged in radio, advertising and publication work before joining Interprovincial.

Diverse Products Batched

However, it was the service pipelines that revolutionized distribution in the first half of the 21st Century. Thanks to the peculiar properties of Tau pipe batches of such diverse products as fruit juices, rocket fuel, liquor, milk, and turpentine could be put through a single pipe without contamination or admixing. Each batch of material received an injection of Tau particles, which had no adverse effect on the material itself. The Tau particles did double duty. They received an electrical charge, which acted against the repellent charge in the pipe itself to produce an almost frictionless method of transmission. For dispatching purposes each batch received its wave length tag through the Tau particles and effected its own delivery when the tag actuated a valve keyed to the same wave length.

Dispatching problems within the system were, and remain, staggering. Even the full use of electronic computers has not eliminated the possibility of errors such as the one that occurred when the National Camp of the WCTU received a delivery of bonded material destined for a Las Vegas night club.

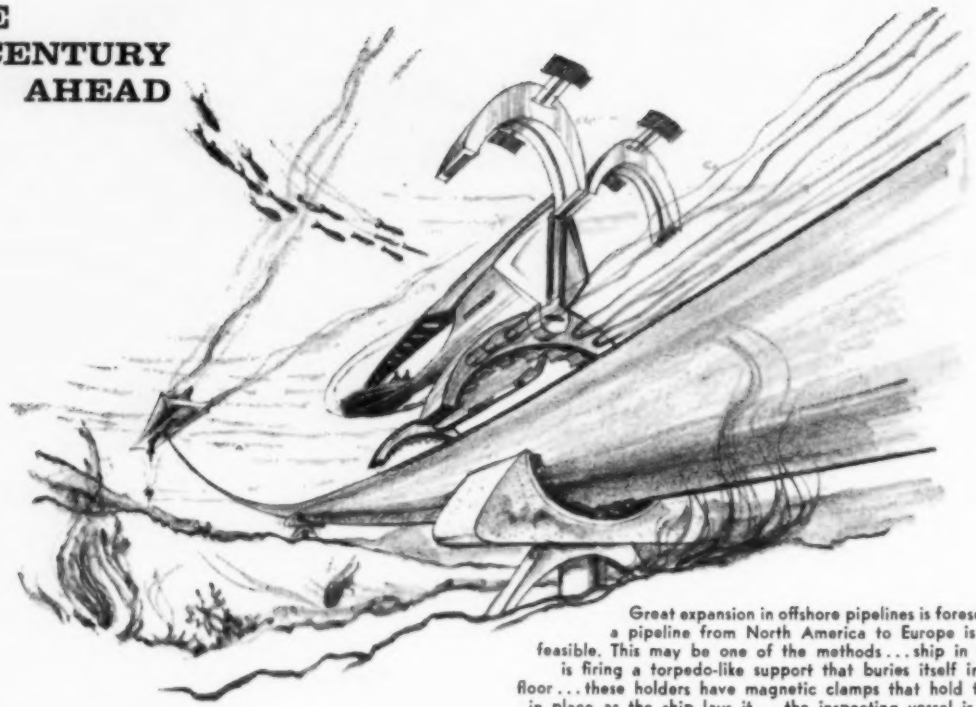
Solar Energy for Pumping

The master and slave pumping system, operated by solar energy and making use of the RBC principle, made possible both the tremendous throughputs required for the great water grid and the infinite variety of deliveries on the service and other lines.

Adaptations of the Tau pipe brought great progress in such areas as forestry and fishing. Control of forest fires became relatively simple with the introduction of expandable and expendable Tau pipe and the portable slave pump. Helicopters could simply drop one end of the pipe into the nearest body of water, unreel it as they flew to the fire and with the slave pump provide adequate pressure for fire-fighting operations. In much the same way the exotic delicacies of the sea were sent from the ocean based ships direct to the seacoast restaurants.

By 2059 the grid had spread across the face of North America and had been adapted not only in most terrestrial countries but had been put to good advantage by the early pioneers of space. ■

THE CENTURY AHEAD



Great expansion in offshore pipelines is foreseen . . . and a pipeline from North America to Europe is viewed as feasible. This may be one of the methods . . . ship in background is firing a torpedo-like support that buries itself in the ocean floor . . . these holders have magnetic clamps that hold the pipeline in place as the ship lays it . . . the inspecting vessel is capable of X-raying and further inspection of pipe . . . and can pick up a broken end and fish for the other, catching it in its jaws at the rear and welding the break.

■ Pipeline from North America to Europe in Near Future?

W. C. Kinsolving, *President*
Sun Pipe Line Company

IN A BUSINESS as hectic as ours and beset with as many unknowns and uncertainties as we have, it is rather hard to gaze even five years ahead much less 100.

First, let us think ahead perhaps only 25 years. Here I can see very definitely that pipelines can and probably will be completely automated to the extent that they will be operated from one central point, through radio channels, with perhaps a few electronics and communications experts to maintain the equipment. As a matter of fact, from a technical viewpoint this could be done now, but it cannot take place until something can be done about the displacement of personnel that would result. As time goes on, this problem will be taken care of by attrition, that is, deaths and retirements and the gradual upgrading of present employees to more highly skilled techniques. As fast as this can be done, full automation will follow.

Line Pipe May Be Flexible Hose

For the next 25 years, at least, I do not believe there will be any material change in the use of steel pipe. Plastics, or some type of flexible high pressure hoses, may come into use. I rather think the use of some form of reinforced high pressure hose will take precedence over plastics because of the extreme flexibility. The Army's program of development on these types of conductors has already proceeded a long way and I think will go much further.

Turbine Drive For Pump Stations

As far as prime movers and pumping equipment are concerned, I think you will soon see the development of high speed, large horsepower turbine drive in place of electrical or diesel. This will follow somewhat the pattern now being set by natural gas pipelines. It is rather surprising to me that oil pipelines have not gone along faster on these developments than they have.

North America-Europe Pipeline?

Another development will be a great expansion in the use of offshore submarine pipelines. I think that if pipelines do not go out of style entirely, it will soon be feasible to lay a pipeline from North America to Europe, similar to our laying of the Atlantic cable. Some studies already have been made regarding the laying of pipelines from Mexico to

William C. Kinsolving

President of Sun Pipe Line Company and Sun-Canadian Pipe Line Company and a director of Mid-Valley Pipeline Company, West Texas Gulf Pipe Line Company, and Detroit Southern Pipe Line Company, has been a pipeliner for 36 years, all with Sun. He served as assistant director of transportation for the Petroleum Administration for War during World War II, and in that capacity figured prominently in the planning and construction of the "Big Inch" pipeline. Later he played a major role in the building of the China-Burma-India pipeline.

Upon completion of his war service in India, he returned to Sun as manager of all pipeline operations. In July, 1947, he was elected president of the Sun Pipe Line Company (Texas) and also of Susquehanna Pipe Line Company. When the two lines were consolidated, December 31, 1951, he became president of the new company, Sun Pipe Line Company of Pennsylvania.

Cuba. If this can be done, there is no reason why it could not be extended to stretch from North America to Europe.

In addition, I think there will be further expansion in the transportation by pipeline of commodities other than oil and gas. The coal pipeline in Ohio is a forerunner of this. You will see the transportation of ores, wheat, and many other commodities that can be formed into a liquid slurry capable of being pumped. This, of course, will bring about a great saving over present transportation by rail or truck.

No Pipelines At All In 2059?

And now to think beyond 25 years and into the future up to 100 years. I seriously question whether there will be any pipelines in existence at all. This is because of the change in the types of energy which will come about. With the advent of nuclear power, the further development of solid fuels and other fuels about which we do not yet know, it is possible that we will not be transporting liquid hydrocarbons at all, in which case some other form of transportation than pipelines will be used.

I feel sure that within the next 100 years much power will be developed from solar energy, from various chemical reactions, and other forms of energy, which will supersede our present types. ■

■ What Jules Verne Said to Leonardo daVinci

Darrell C. Morrow, *Junior Engineer*
Texas Gas Transmission Corporation, Owensboro, Kentucky

IF JULES VERNE and Leonardo daVinci had been pipeliners in this 100th year of commercial production of oil, they would be thinking, not of what progress has been made since 1859 but rather of what changes will have been made by 2059. Let us listen to them while they discuss the next ten decades of natural gas's march through time.

Verne: In 2059 the gas business will be dead but believe me, I'm advising all my friends to buy up the old distribution systems. I can see the day when the giant, and for that matter the not so giant, cities will be dead without fresh country air. I propose to pipe in fresh country air to the heart of the cities through the present gas distribution systems.

daVinci: You're dead wrong about the gas business being dead in 2059, but still I can see how L. A. would welcome such a system. We could probably add insect repellent, wood preservatives, and possibly conditioned air to the system. You got any more bright ideas, Jules?

Verne: On that study of matter energization that we made sometime ago—do you agree that methane would be an ideal compound to use as a base? I believe that we could treat methane so that it would give off a light to match the brilliance of the sun.

daVinci: Great, man, great! We could sure use something like that near the runways of our large airports. Jules, you remember that gadget called a Hilsch Tube that came out during World War II?

Verne: No, what is it?

daVinci: It's a fancy little trick that through the movement of a gas from a high pressure source to a low pressure region splits the stream itself into two streams, a hot stream and a cold stream. I believe that we could utilize the cold stream for air conditioning and refrigeration and the hot stream for conduction and radiation heating. The two spent streams should then be reunited to be used in low pressure convection heating.

Verne: Say, Leo, I believe that all this thought on gas suggests a solution to the iron ore problems.

daVinci: What iron ore problem?

Verne: I think that we'll have to tap the iron ore at the core of the earth. With natural gas to heat the annulus around the producing string we'll be able to get the iron ore to the surface in the molten state.

daVinci: Do you still intend to use those 100,000 psi wells to operate the gas-rotated bits?

THE CENTURY AHEAD

Flow of gas will be controlled by computer, which receives its data from automatic weather forecasters at various points of use. Through satellites and weather stations weather is created in a miniature scale model, complete with atmosphere and relief map of the world. The two control panels directly in front of the operator are televised from panels in other stations, and are controllable by a master panel at his finger tips. Monitors are monitoring outlying sub-stations.

Verne: Yes, we'll use those ultra-high pressure gas wells to turn the bits in our quest for iron ore as well as to operate those giant augers that I mentioned.

daVinci: Giant augers?

Verne: Oh, you remember. Those giant augers that are to be used to drill shafts connecting the world cities. We must remember to give more attention to South America and South Africa in this shafting operation.

daVinci: Speaking of shafting — I believe that those customers who still use fuel oil are really getting the shaft. With liquefied methane as cheap and as safe as it is these days, I can't see why people don't change over.*

Verne: I believe that they will when we get this supply system stabilized.

daVinci: Your plan to float the immiscible liquefied methane on the surface of the ocean from the middle eastern ports to the world's ports should certainly stabilize the supply.

Verne: Leo, by 2059 they will have discovered that Jupiter has solidified methane near the surface like Earth's coal veins and that Uranus has no fuels at all. I suppose that they will extrude the solidified methane like toothpaste from a tube through an electric field pipeline from Jupiter to Uranus.

* * *

Now a Lower Powered Telescope

So much for Messrs. Verne and daVinci. Let's use a telescope of a little lower power to look at the future. Current research by the trade associations indicates that in the not too distant future we can expect to be using our pipelines for communications channels as well as for gas transmissions. Loss of signal and exterior interferences are seen as significant but not insurmountable problems.

The 15-year sustained trend toward medium pressure, large diameter lines seems to be approaching a peak. Annual costs of high pressure (1200 psi), small diameter lines for comparable volumes, vividly points out the poor economics of medium pressure, large diameter systems. As better steel is developed for use in compression engines and in the pipeline itself, we can expect small diameter, high pressure lines to once more be the vogue.

*It is obvious that Mr. Morrow is a gas man.

Darrell C. Morrow

He joined Texas Gas Transmission Corporation June 1, 1957, after being graduated from Purdue University with a BS degree in chemical engineering. Previously he had worked three summers for the company as a college trainee and one summer for Pure Oil Company as a roustabout. His position with Texas Gas is that of junior engineer in the planning and research department. He holds the rank of second lieutenant in the active reserve of the U. S. Army and was on active duty from October 21, 1957, to April 21, 1958.

There seems to be no fabrication technique that will create a smooth surface for the inside of steel pipe. It is felt that an internal coating on all pipelines to increase the flow efficiency and to diminish the dusting problem will become as common as presently used external coatings.

At present the flexibility of compressor station design is shackled by the low limit on compression ratios caused by the low heat tolerances of today's external coating materials. In the very immediate future this problem will be met and bested.

The successful voyages of the "Methane Pioneer" will serve as a launching pad for a deluge of capital being poured into the liquefication of presently wasted natural gas in remote supply points for shipment to areas that are hungry for fossil fuels.

Gas metering will likely become a science of measuring weights rather than volumes in order to escape the problems of super-compressibility. Gas will be sold on a Btu rather than on a volume basis in the not too distant future.

Underground storage has been very successful as a peak shaving device to lower the average price of gas to the ultimate consumer. Unfortunately, it is impossible to always find facilities suitable for underground storage where they would do the most good, near the market. Some gas people are discussing the possibility of natural gas being stored in man-made reservoirs in the liquid state. These man-made reservoirs could of course be placed at the most advantageous sites.

THE CENTURY AHEAD

The era of complete operation of any industry with giant computers is in the far, far future, but we can expect to see in our lifetime segments of our own industry operated without many of the persons now required. Remote operation of compressor stations, remotely operated valves, remote operation of storage fields, and the such will free many good men for more creative endeavors.

Products from the gasification of underground stocks of oil, tar muds, and coal deposits inevitably will be in a position to compete economically with natural gas if the current trend in production costs of natural gas is sustained. Thermonuclear reactions promise to be an excellent source of heat to release the gas from these formations. Some pipeliners are looking to that day when the present pipelines in the "pipeline alley" connecting the Gulf Coast and the Appalachian Area will be moving gas from the coal deposits in the East to the petrochemical industries in the South.

The limit on the range of our futuristic telescope has been reached so we'll leave further speculation to the Vernes and daVincis among you. ■

■ 2,000,000-PSI Steel, 20-Hr Work Week?

W. T. Bulla, Director of Operations

D. C. Palm, General Superintendent, Pipeline Division

C. S. Kenworthy, General Superintendent, Compressor Division

Natural Gas Pipeline Company of America

IN LOOKING AHEAD we foresee production of petroleum products in much greater quantities and in many new lands and offshore locations. Canada, Mexico, Africa, South America, and other countries in the Western Hemisphere undoubtedly will account for huge productions. Continued use of petroleum products will be greatly expanded and, no doubt, production from shale and coal will become a feasible and practical source of supply.

Products and derivatives from petroleum and natural gas will be expanded into hundreds of items unknown at this time.

Only Real Energy Items Pipelined

Technological developments will remove some of the components from natural gas prior to its transportation to market areas so that the only commodity handled will be the real energy items.

Transportation cost of liquids and gas will be greatly reduced with tubes able to withstand higher pressures and so constructed or coated to reduce markedly the friction now experienced in present day pipelines.

Lightweight alloy metal and/or plastic pipe will be developed that will have a lower production cost, be less expensive to handle due to lightweight, and be much more efficient in its capacity.

As metal alloys with higher heat resistance become available, the increased efficiency of combustion turbines no doubt will result in their being used widely in pumping stations.

2,000,000 Psi Steel

The possibility of obtaining extremely high strength steels by methods yet unknown has recently been indicated in the General Electric laboratory where steel has been produced in the form of fine hairs with 2,000,000 psi tensile strength. This could make possible very high operating pressures, and possibly with reasonable manufacturing cost.

Atomic energy, only getting started in some of the fields where it will be greatly used, will supply a large part of the energy now provided by present day fuels.

A 20-Hr Work Week?

Much of the operating labor now employed in oil pipeline and compressor stations will be eliminated entirely and the general operation of these facilities will be handled automatically. Starting, stopping, and other operating functions will be handled remotely from a central point, and with various types of shutdown fail-safe apparatus, these stations will not require attendance around-the-clock. Essential operating data will be transmitted electrically from each station to a central headquarters or dispatching office.

Maintenance of these facilities can be largely labeled "preventive maintenance," which will include periodic overhaul of equipment. This will change working conditions for station crews in that more specially trained technicians will be required, who, for the most part, will work daylight hours only, and probably within the next 100 years these technicians will complete their normal work week in 20 or 30 hours. ■

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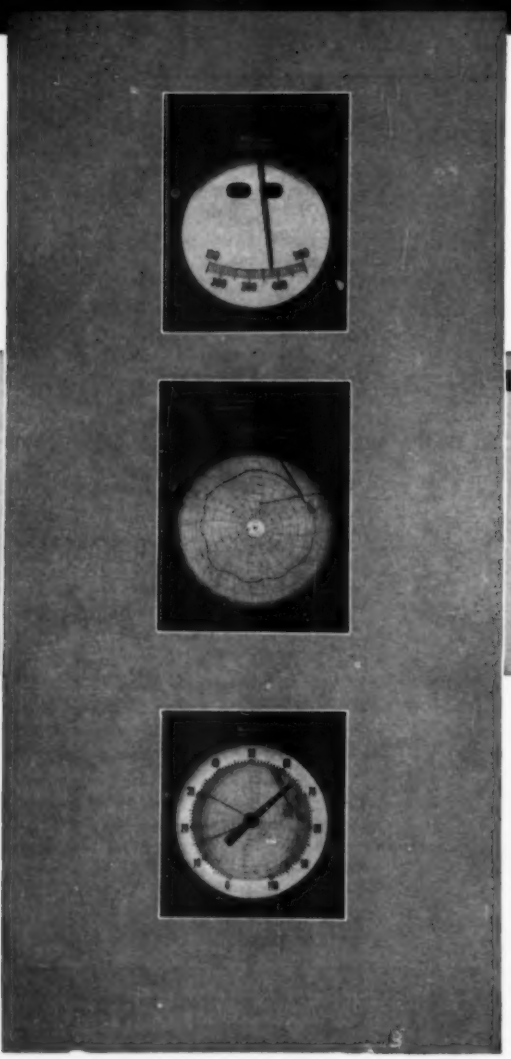

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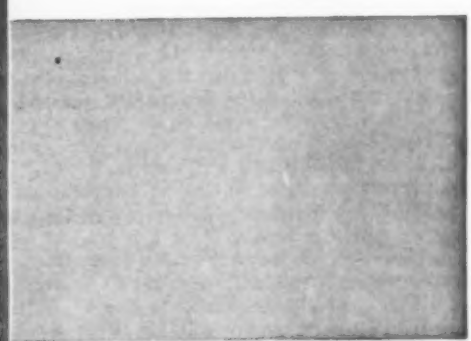

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THE
CENTURY
AHEAD

A New Pipeline Concept

Proposed for this pipeline for the future are principles not generally used but entirely sound from hydraulic and mechanical standpoints

Sydney S. Smith
Pipeline Consultant, New York City

THE ROLE OF A PROPHET is one which should not be taken lightly. Should his predictions prove true most people forget who made them; should they prove false everyone remembers!

In the light of the improvement in pipeline techniques during the last two decades, however, there is ample room for interesting speculation toward the future. It would be presumptuous to look too far ahead, but as a start it is perhaps expedient to look at the relative strengths and weaknesses of pipelines competitive to other forms of transport. From these factors it may be possible to deduce the possible future of pipeline development.

Thus, we may at the outset accept the fact that the pipeline is the cheapest form of overland liquid transport where there exists a constancy of demand for transportation. This factor is in the pipelines favor, but only partially so in that to attain such a favorable economic situation the quantities to be handled must be large. This qualification extends not only to total quantities, but also to the individual or batch quantity. Thus, almost at once we point a finger at the most pressing development need for the modern pipeline—the need for improved or perfected batch separation. This applies to crude lines, product lines, and preeminently to the future of liquid chemical lines.

So I propose to speculate on how we can construct and operate a line that will achieve, to all intents and purposes, a perfect separation technique. Such a line could handle batches of any size, have any desirable batch frequency, achieve complete automation in "take-off" to terminal delivery stations, and withal be simple to dispatch and operate. The savings in tank requirements, in frozen inventory cost at both input and delivery points of the line are self evident. This package line could handle crudes and products interchangeably, and in some circumstances even liquid chemicals in the same line.

Would Require New Concepts

Several new concepts are required to make this hypothetical line feasible and practical.

First and foremost, different liquids must be positively mechanically separated.

Second, the mechanical separation means must go through intermediate pump stations clean, that is to say the stations must be cleared of the first product so that the mechanical separation device is not displaced from its exact position in the liquid stream.

Third, the interior surface of the pipeline must be of a material that is glass hard and smooth so that it can be "squeegied" as we do the glass under a windshield wiper.

Fourth, the various liquids must be started into the line with a clean interface. This last qualification precludes the use of the "flying switch," which crosses the operation of two valves, one closing and one opening simultaneously, for this method creates an interface mixture before the two liquids leave the first station.

Now with these premises we can begin constructively to examine our problem in its separate phases. For the moment let me suggest that we forget costs, since we have such tremendous savings achievable in reduction of associated tanks and inventory that we can spend liberal amounts on our hypothetical pipeline and still come out well "ahead of the hounds."

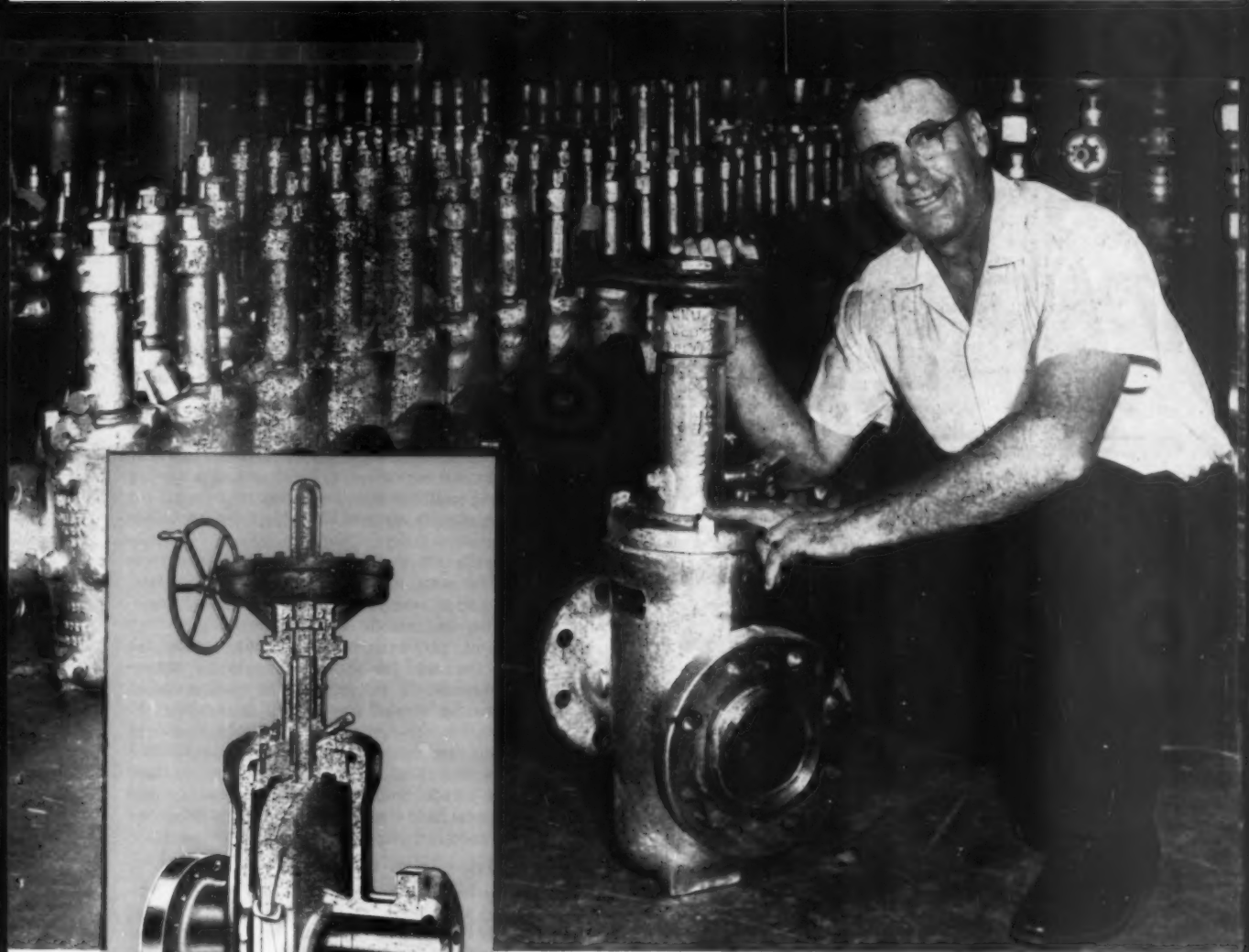
The Mechanical Separation Problem

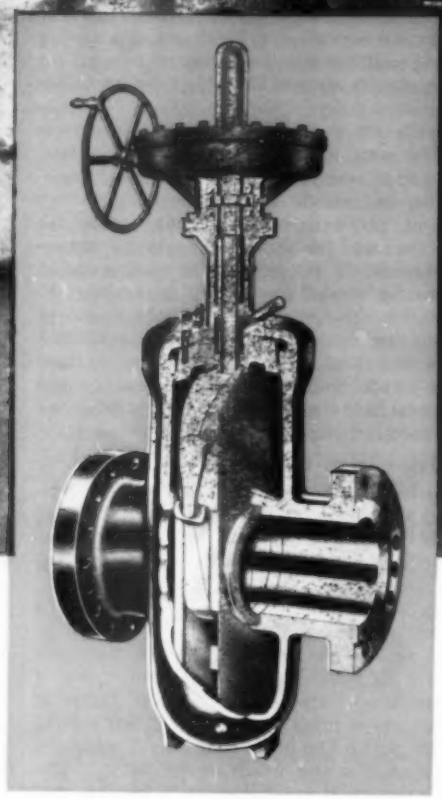
We can examine mechanical separation first. Techniques have been developed that permit excellent separation of the diffuse mixture in product pipelines, but the problem of the adsorbed volume on the pipe line wall remains unsolved. This volume is the wetted surface of the pipe including the tiny volumes held in the minute irregularities of the steel surface, and these volumes can be fairly accurately computed in relation to total exposed surface. Because by present mechanical separation methods using spheres or scrapers this product can only be removed by solution in the following product in the line, the best separation now obtainable is only effective enough to minimize mixtures. Even then present methods require multiple separators in the line without taking into account the additional mixtures that occur by passing the separators through intermediate stations.

If we can make an interior surface on the pipe that is glass hard and perfectly smooth, a rubber squeegee will wipe the surface dry of the leading product. Perhaps the new plastic pipes can be made to have such a surface, although the creation of perfectly smooth and flush joints would seem to create a serious problem. More likely the presently known techniques for internal thermo-setting plastic coatings can be improved to provide such a surface.

We do have techniques available for eliminating nonconcentric pipe or welding icicles at steel pipe welds by the use of internal line up clamps fitted with copper shoes. Similar methods will be used in this line.

At any rate, we deal here with assumptions, and the extension of existing techniques to include internal coatings of pipelines to the specifications delineated above does not seem too far fetched. Given such a surface we eliminate the "wall cling" mixture.





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THE CENTURY AHEAD

Passing Separators Through Stations

Thus, we may consider the second requirement for perfect batch separation, that of passing separators through pump stations "clean" and in place in the stream.

Existing methods have several faults in design or execution. One method shuts down the station on scraper arrival (scraper used in the sense of a single or multiple series of scrapers, spheres or dissimilar product buffer between mechanical devices), permits the scraper to pass, and restarts the station. This procedure reinjects the volume of first product held in the station as a mixture into the following product at an inaccurately controlled point in the stream.

Another method throttles the station sufficiently to split the stream through the pumps and the station bypass, the latter carrying through the scraper(s) on the bypass stream. This method is reasonably effective, but only as accurate as the "split," which may be unduly disturbed by the resistance to scraper(s) passage through the bypass check and station connections, or by change of line rate.

Still another method primarily used with spheres (but possible with scrapers) measures the volume in the station and double valves the spheres through short connections from suction to discharge side of stations, presumably to the original point in the stream. This method involves split second accuracy in valving and becomes somewhat "hair triggery" in operation.

A More Reliable Method

For our hypothetically perfect line I propose a more reliable method, which involves one or two principles not generally used, but entirely proper from hydraulic and mechanical standpoints. Hydraulically we space our stations at half hydraulics (half the design pressure of the line) — thus any station can "go down" without materially affecting flow, and any down station can be replaced by an extra half hydraulic unit in the primary originating station or one intermediate station. We may pay a small premium in first cost of power, but with this design we can almost wholly eliminate throttling losses, because we use only the required number of units along the line and "carry through" residual pressure to the needing downstream section of the line.

When a separation device approaches a pump station it actuates a trip, which shuts down the station and closes its intake and discharge valves. When these valves are closed we immediately drain the pump and station piping, pumping the station content of leading product back into the line before the separator arrives in the station. As soon as the separator passes, the station is refilled from the following product in the line and resumes operation.

This whole sequence being automatic and requiring only a few minutes to complete does not appreciably reduce line throughput, and with the station controls later described does not materially affect the control of adjacent stations. The incoming trip must be located far enough upstream to provide station drainage time. If multiple separators are used a count up of entering separators and count down of departing scrapers is required before refilling and restarting the station. The specially designed equipment required for this draining operation is already available from an industrial supplier.

Before leaving the station description one or two features of design should be noted. If we are to have repeated starts and stops in a station, the sequencing should be simple, absolutely reliable, and should include throttling control that guarantees no prime mover overloading while the station unpacks the upstream line and packs the downstream line. Because during this pack-up the starting station pumps more than the normal line rate, it is necessary to fit the station throttle valve opening rate to the weight of product on which the pump is starting. At the moment I know of only one throttling control system that meets these requirements, but since both the electrical sequence and this throttling control have been described in other published articles, it is not necessary to repeat the descriptions here.

Placing the Separation Devices

Now we need look at the problem of placing the separation device(s) exactly at the interface. Again we must be realistic in what we are doing and to do so we must give up some of our conventional and perhaps archaic thinking about pipelines.

Conventionally we hate to stop flow in pipelines. In conventional lines there is some reason for this reluctance. We make flying switches to sweep the intake manifolds and thus endeavor to minimize starting mixtures. But if we have long collection lines from larger tank farms or several remote sources of input we must "gait" our valving to accord with the pickup rate in the long lines or engender surges or abrupt changes in rate, which are difficult to handle in the originating station. If we shut down in conventional

Syd S. Smith

He has always been a forward looking person, and is credited with many innovations in the products pipeline field, particularly in the area of automatic operation. His inventive genius also was demonstrated during World War II when he developed a portable pipeline that was used to supply the allied armies with petroleum products. For this achievement he was awarded the U. S. government's Medal for Merit.

Smith was graduated from Marietta College, Marietta, Ohio, in 1915, majoring in mathematics and physics. For a number of years he was associated with his father in selling pumps and compressing equipment, then as a builder of gasoline plants. In 1925 he became manager of the natural gas and natural gasoline division of Roxana Petroleum Corporation, later to become Shell. He held this position until 1935, then served for three years as special consultant in the manufacturing department. In 1938 he was appointed manager of Shell Oil Company's Products Pipe Line Division.

Since retiring from Shell a few years ago he has been doing consulting work, making his headquarters in New York City.

Arrangements have been made by PIPELINE ENGINEER for a later and more fully descriptive article on the subject discussed here when patent disclosures can be made.

interface lines we add to standing mixtures between products in the line. So there are reasons for present reluctance to shutdown lines.

But in our hypothetical line shutdowns do not harm interface contained by mechanical separators. Nor in a line controlled from a central point, from which all stations can be started or stopped simultaneously or in a completely automatic line, does a short shutdown lose significant amounts of throughput. So we may consider either of two methods for our start of a clean interface between two products. One involves only a momentary shutdown time of perhaps 10 to 15 minutes, which, however, is too long for the line to absorb without stopping downstream stations.

The short operation requires two complete originating stations. Each station is individually connected to the outlet scraper launching barrel on closely valved connections so that either unit can pump into the line downstream of the scraper or upstream of it to launch. When not operating, one unit is drained as done in the line stations. The station content liquid is pumped into the proper collection line from which it originated, or if it came from a long collection line handling several products, it is stored in a small hold tank to await and join the next similar shipment. This may involve a number of tanks, but they are only large enough to retain the station fill and are piped with small connections. In this manner one station brings a new interface into an empty pump and lines right up to the scraper to be launched.

When ready the first station is shut down and the new station immediately started with its own product exactly behind the departing scraper. No initial station interface mixture is created and the momentary shut down does not stop any of the downstream stations. Further, the newly starting station can pick up its pumping rate in synchronism with the input line rate of pick up.

Proposal Has Some Faults

Now we can examine our proposal for faults. We have assumed that we can "squeegee" our smoothly lined pipe perfectly clean of the leading product. To all intents and purposes this has already been done in carefully controlled experimental scraper runs in commercial lines, although the scrapers used were anything but conventional. Nor in these experimental runs was it possible to entirely eliminate the effect of liquid passing back over the scraper due to the absorbed volume of liquid held on the pipe walls.

Another and still more serious problem was encountered in that the pipelines did not constitute a continuous conduit, which could be swept by a scraper, but contained numerous side pockets where station suction and discharge valves or side connections of one sort or another existed, or contained valves that themselves were constructed with fairly large volume pockets.

So a vital need for this hypothetical pipeline is a valve that can either provide a smooth through-conduit or alternately a simultaneous through-conduit and a side open connection. It might be a three-way conduit plug valve, or two valves built in a tee with the closest possible similarity to a true conduit when the side opening is closed. At any rate it is to be hoped that some alert valve manufacturer will see this comment and come up with an answer in the form of a proper valve.

In commercial steel pipe the wear of scraper disks is a vexing problem, but in a smooth lined pipe they should run for hundreds of miles without serious wear. Thus, in this line all scrapers would be run to the end of the line without intermediate trapping.

Automatic Station Draining

Because of patent complexities no description of the automatic station draining will be detailed here, but it is proper to note that the special equipment is ready for the first user who desires it.

The technique of draining an originating station to provide a clean interface when starting a batch is not new. It is not used in conventional pipeline operation where an interface mixture is going to be created in any event, but in this line we would need a clean starting interface to accord with the separation efficiency of the rest of the system. The extra pump and meter assembly required to provide this dual flexibility of station operation is a small price to pay for the benefits that accrue. If no second station is provided, then we need to supply an easy and automatic drainup procedure for our single station and live with our small loss of potential throughput.

What Are the Advantages?

Now we need to look at some of the things we can do with this line.

First, we can vastly improve our measurement practices, since regardless of the type of meters used, we make all measurments at constant rate and this alone cures one of our most troublesome metering problems.

We can, relatively simply, address our batches from the initiating station for delivery to the terminal and tank to which they are destined. This implies that all "takeoffs" should be a line rate, and here our hypothetical line has an advantage over the usual line, in that we can rapidly open or close valves and the resulting hydraulic shocks cannot approach destructive pressure because of our shorter station spacing and our half hydraulic stations.

There are several methods by which we can identify incoming batches automatically. These methods, being subject to patent, will not be described here, but it is enough to say that from the originating station it is possible to properly direct the opening and closing of terminal offtake and tank valves so that each addressed batch goes to its proper tank.

Likewise *simple* hardware is being made available for the readout and remote transmission of meterized digital volumes to a central point, as is all hardware for remote tank readouts to observe terminal stocks from a central control point.

We can, therefore, visualize in our hypothetical line a cycle time (all products moved in each cycle) not based on 25-50,000 bbl in a batch, but based on the individual terminal tank product requirements and with all terminal withdrawals handled automatically, and all withdrawals remotely recorded in the central control office.

This hypothetical line can handle crudes, refined products, LP-Gas, and if operated dry or buffered with a dry stock, even liquid chemicals. It will require surprisingly small tankage at input and terminal points and, because it can operate with less manpower and less power wastage than present lines, will cost no more to build and operate. On the other hand, inventory savings, reduction in tankage cost, and elimination of mixture disposal problems will operate as plus economics.

Design Does Not Add To Cost

This line embodies significant differences from usual thinking. There are more stations closer spaced. On its face, and contrary to the figures on which station spacing calculation are made, this design does not necessarily add to cost. It involves single unit stations rather than multiple units. Consequently, control is much less costly and com-

plex and, in fact, such a line can, if desired, be made completely automatic without benefit of supervisory control.

Power losses due to throttling of pumps can always be reduced to minor balance throttling in one station, for at any through line rate all stations except one can be made to float between an elevated suction pressure and a depressed discharge pressure (below line design). Unless these factors of variable rates, which exist in all pipelines, are properly taken into account the calculated optimum station spacing concomitant with full use of line design pressure can be and is quite misleading.

Also contrary to usual thinking, it costs little if any more to build and operate a given horsepower in a number of small stations than in fewer large stations. There are a number of reasons that make this so. The single unit station is intended to operate unmanned, thus units are set outdoors and only switchgear housing is required. This concept eliminates utilities such as water and heating, requires only sufficient "office" to house charts, small supplies, and the teletype for occasional maintenance personnel communication during periodic service calls.

As regards the line itself, the use of horsepower in pumps is much more efficient in this type of stationing because the "float" pressure from high suction is carried through each unit to the last operating station, which then only requires "trim" throttling. This feature is possible only if there is sufficient latitude in the line operating pressure over the station boost pressure to compensate for one complete station, a feature that is also necessary to permit station by-passing for product separation.

Another advantage exists in this type construction if the line is fully loaded. Loss of a unit affects the line only in the ratio of the lost unit's horsepower to the whole upstream horsepower, whereas in a line using full pipeline design pressure in each station the loss of the station reduces the line throughput by approximately 35 percent of total line capacity. If a unit is lost in a station containing two or more units the line capacity is still reduced in much greater degree. The single unit half-pressure station in most cases provides the lowest cost per horsepower possible.

Automation Is Simplified

Automation of our hypothetical line is greatly simplified compared to conventional multi-unit stationed and stripping rate offtake lines. The line runs at normal average rate to the working delivery point. Downstream it is shutdown automatically by the opening of the takeoff valve at any upstream point. Reclosure of the takeoff valve at end of batch starts up required downstream stations without additional attention from the control office.

The actuation of any station bypass operation is signalled to the operation office over the monitoring system and the discharge pressure of each station can be "read out" over the control circuit, and stations can be started or stopped in groups or singly so that the central control office always has full control of line throughput. Offtakes can be handled automatically, as noted, or, if terminal points are manned for other reasons, can be simply and accurately operated by local personnel. Measurement can be very precise in view of the constant rate metering. The station automation becomes extremely simple in this line as noted above.

Full stream takeoff methods advocated leave the line always operating on a point-to-point basis with only one metering point at input and one at takeoff. Thus, pipeline volume accounting is always simple, there are no adjustments to make to shipped volumes to take care of up or downgrading, and if remote digit readouts are required to accord with automatic data machines, only one geographic point requires readout at any one time, so that this phase can be handled with available hardwares over normal teletype control circuits.

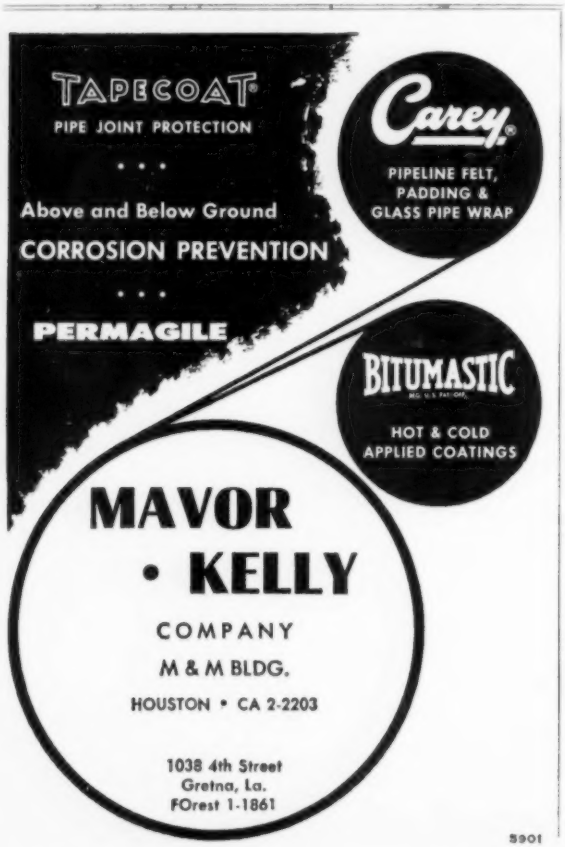
Taken all together these factors spell ease of maintenance control and dispatching with great savings in tankage and frozen stock inventory.

Perhaps this article should not be called a prophecy, but rather a suggestion for design. The bits and pieces suggested at one time or another have all been proved experimentally or in practice. Where some of the concepts suggested have been put to use in working lines, one or another improper choice of hardware or technique has prevented full and proper utilization of the principles involved.

In the constant search for better techniques and lower costs it must be assumed that whatever engineers can imagine and visualize they can also accomplish.

Whether the design concepts suggested herein are ever implemented, or whether other and better methods are originated, the need for such designs are real and apparent, and that end will be met by the ingenuity of competent designers.

Thus, I would like to think that this may be a sound prophecy after all even though the details of its accomplishment may only bear slight resemblance to the detail I have suggested. In either event, only time will provide the answers. ★ ★ ★



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Pipeline Projects

Transwestern Expects to Deliver Gas by Winter

Transwestern Pipeline Company, following numerous setbacks, has good reason to expect approval by August 1 of the Federal Power Commission to construct an 1809-mile pipeline to supply gas to southern California markets. Presiding Examiner Harry W. Frazee has ruled that the permit should be granted, and in making this decision overruled the FPC staff and the California Public Utilities Commission, who held that gas purchase contracts made by Transwestern were too high. Indicating that a fast and favorable decision by the entire commission staff may be forthcoming is the fact that the usual 20-day period for exceptions to be filed was cut in half and an oral hearing scheduled.

Construction will begin immediately, as most of the line pipe had been delivered to the right-of-way prior to the granting of the permit, and conditional contracts had been made with H. C. Price Co. and Houston Contracting Company.

Transwestern's main line will be 30-in. in diam and will originate near Roswell, New Mexico, extending 670 miles to the California-Arizona border near Topock, Arizona. Two feeder lines will bring gas to the Roswell Junction. A 20 and 24-in. line will extend 252 miles from the Puckett field, Pecos County, Texas. The second, a 24-in. line, will extend from Canadian, Hemphill County, Texas, a distance of 298 miles.

Initially, Transwestern will deliver 300,000,000 cu ft a day to Pacific Lighting Gas Supply Company, who will resell to distribution companies. The project is expected to be completed in time to deliver gas for the coming winter consumption.

Cost of the system will be $191,-700,000.

Organizers of Transwestern are J. R. Butler of Houston, Texas; Warren Petroleum Corporation, Tulsa, Oklahoma, and Monterey Oil Company of Los Angeles, California.

Texas Eastern Acquires Rayne Field Reserves

Texas Eastern Transmission Corporation has received Federal Power Commission authorization paving the way to add approximately 1 trillion cu ft to its natural gas reserves, according to Orville S. Carpenter, president.

The new gas reserves will be acquired through purchase, at a cost of some $134,000,000, of the leasehold producing interests of the Rayne gas field, Acadia Parish, Louisiana, from Continental Oil Company, Sun Oil Company, General Crude Oil Company, and M. H. Marr, joint developers of the field, Carpenter said. Purchase arrangements provide for an initial payment of some $12,400,000 in cash with the balance of $121,975,000 to be subject to further payments over a 16-year period. The Rayne field gas purchase represents an increase of some 7.5 percent in company reserves, Carpenter said. At the end of 1958, Texas Eastern had under contract reserves totaling approximately 13.2 trillion cu ft.

The company will begin construction immediately on a 22-mile 14-in. lateral from its Opelousas, Louisiana, compressor station to the Rayne field, covered in the recent authorization. In addition, authorization includes final approval to construct additional 30-in. loop lines on the company's main trunk between Kosciusko, Mississippi, and Uniontown, Pennsylvania, at a cost of some $49,000,000, previously authorized under a temporary certificate.

The FPC ruling also gives the company final approval on its application to increase daily sales of its system by 100,000,000 cu ft.

Cities Service Gas To Increase System

A large portion of Cities Service Gas Company's 1959 construction program has received temporary authorization from the Federal Power Commission.

Estimated to cost $8,217,000, the facilities — needed to enable the company to meet the increased demands of its existing customers — includes approximately 22 miles of 30-in., 16 miles of 16-in., 25 miles of 12-in., and 3 miles of smaller pipeline, as well as installation of an additional 2140 compressor hp. The company also proposed to develop the depleted Denton and Ferguson fields in Elk County, Kansas, as underground storage areas.

CONSTRUCTION

FEATURE

El Paso Files for Line to Serve Southern California

Applications by El Paso Natural Gas Company, and Pacific Northwest Pipeline Corporation, proposing the construction of natural gas pipeline facilities costing an estimated $58,858,-000, having been accepted for filing by the Federal Power Commission.

El Paso proposes to construct about 394.6 miles of 34-in. pipeline from Thistle, Utah, to a point on the California-Nevada boundary southwest of Las Vegas, Nevada. Cost of this construction is estimated at $58,685,000. Facilities would be used by El Paso to sell to Southern California Gas Company and Southern Counties Gas Company, both of Los Angeles, California, a maximum of 470,000,000 cu ft of gas per day.

To carry out this proposal, El Paso would purchase a maximum of 235,-000,000 cu ft of gas daily from Colorado Interstate Gas Company, of Colorado Springs, Colorado, and a maximum of 235,000,000 cu ft per day from Pacific Northwest, in the vicinity of Rock Springs, Wyoming. Colorado Interstate proposes to build facilities to transport the gas from Rock Springs to the Thistle interconnection.

Pacific Northwest proposes to build a measuring and regulating station at a cost of approximately $173,000 and to sell natural gas to El Paso at Rock Springs.

International Notes . . .

Construction over a 3-year period is anticipated on Shell's projected 160-mile, 20-in. pipeline from their Tandjung oilfield in South Borneo, Indonesia, to their Balikapapan refinery on the coast. To avoid heating the highly paraffinic oil along the line, it will be pumped in suspension with about 30 percent of water.

Tenders have been invited for the construction of the 16-in. Israel pipeline, which will have an annual capacity of approximately 37,000,000 bbl. Line will extend from Elath on the Red Sea to Beersheba, 200 miles to the north, where it will connect with the pipeline to Haifa.

Work Starts on Penn Line, FPC Authorizes Another

New York State Natural Gas Corporation has started construction of a 37.3-mile pipeline extending from the company's present Line 280 south of Luthersburg, Pennsylvania, to its Valley Gate connection near Rural Valley, Pennsylvania. The construction has FPC approval.

The 20-in. line, planned for completion in September, will be constructed through Clearfield, Jefferson, Indiana, and Armstrong counties.

When the pipeline is completed, New York Natural will have a "loop" of transmission lines from Armstrong to Potter counties. The new line is to be connected with two parallel transmission lines near Rural Valley. Should the two other transmission lines be taken out of service for repairs or maintenance, the new line would continue service to the North.

The Federal Power Commission also authorized New York State Natural to construct 29.5 miles of 20-in. line and two measuring and regulating stations at a cost of about $1,649,300 in order to deliver additional volumes of gas to Iroquois Gas Corporation. The latter has authorized Iroquois Gas to build 7.5 miles of 8-in. pipeline to enable it to transport to market a portion of the additional gas to be received from New York Natural.

Final "Go-Ahead" For Three Gas Lines

Three temporary certificates reported in the June issue of *Pipeline Engineer* have become final, the Federal Power Commission reports. They involve Equitable Gas Company, The Manufacturers Light and Heat Company, and Hope Natural Gas Company.

Equitable is authorized to construct 12½ miles of 16-in. loop paralleling a section of the company's existing system in Harrison and Marion counties, West Virginia, and an 880-hp compressor unit at the Pratt station in Greene County, Pennsylvania, at an estimated cost of $1,250,000.

Manufacturers' authorization involves, at a cost of $5,380,000, 61 miles of 20-in. pipeline and a 700-hp compressor station on the company's system in southern Pennsylvania, as well as abandonment of five parallel 6-in. lines totaling 135 miles in Fulton and Bedford counties.

Hope is authorized to construct in Wetzel and Monongalia counties, West Virginia, at a cost of about $2,134,700, 20 miles of 24-in. transmission pipeline, two metering stations, and appur-

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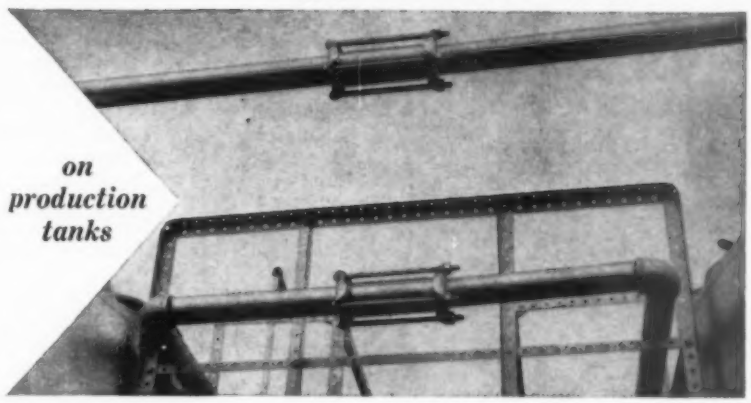

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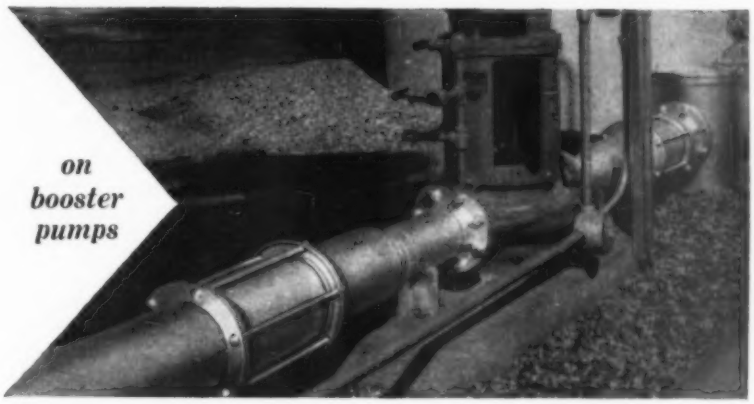

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tenant facilities, as well as to abandon two 16-in. lines which the new line will replace to provide assurance of continuous service to two existing customers, Peoples Natural Gas Company and The Manufacturers Light and Heat Company. The new line will have a maximum capacity of approximately 153,000,000 cu ft daily to Peoples and also will be able to supply up to 16,000,000 cu ft per day to Manufacturers, the same quantity presently being delivered.

August Start Planned For Louisiana Loop

Columbia Gulf Transmission Company's 41-mile, 24-in. loop addition to its East Lateral in Louisiana is scheduled to get underway about August 15, pending FPC approval of the project. The single loop, which would stretch from the Lake Sand Junction on the east to the Erath Junction on the west, would expand the gathering system to a total of just over 450 miles of pipe and would provide full looping of the East Lateral from the Rayne station to the Lake Sand Junction.

Work on plotting the course of the new loop has already begun, with Al Gautreau as field engineer and Sidney Smith and John Halverson as party chiefs.

To be put in the ground south of the existing lateral, the loop will run through dry land except for seven crossings: Three on the Bayou Petite Anse, one each on the Charenton, Franklin, and Hanson canals, and one on the Yellow Bayou.

The new East Lateral facilities are scheduled to go into service about November 1.

Examiner Decision Okays 590-Mile Line

A Federal Power Commission examiner recommended Southern Natural Gas Company be given permission to build $55,266,000 of pipeline facilities.

Examiner Emery J. Woodall's decision, which is subject to review by the full FPC, also would allow South Georgia Natural Gas Company to build $1,947,000 of facilities to make new gas sales. South Georgia would buy its gas from Southern Natural's expanded capacity.

Southern Natural proposes to build 590 miles of pipeline and add 8624 hp to its system. If approved, the construction would boost the system's maximum delivery capacity to nearly 1.4 billion cu ft daily from about 990,000,000 cu ft.

The examiner's decision is subject to review either upon appeal of the parties in the case within 20 days or on the FPC's own motion within 10 days thereafter. If no review is begun within this 30-day period, the decision becomes final.

FPC Passes on Part of Transco Proposal

The Federal Power Commission has granted Transcontinental Gas Pipe Line Corporation temporary authority to construct and operate natural gas facilities costing about $29,457,000. Facilities are to be operated temporarily only for existing authorized service pending final disposition of the application.

Transco was authorized to build four new compressor stations having a combined capacity of 37,280 hp to add a total of 18,000 hp to eight existing compressor stations; to build 13 miles of 24-in. supply loop pipeline and 17.68 miles of 20-in. loop lateral sales line, and to construct three distribution meter stations for service to existing customers.

The facilities are part of a larger proposal by Transco to build facilities during 1959 and 1960 at a cost of approximately $76,910,449 designed to provide 156,000,000 cu ft daily of additional pipeline capacity to meet the increased requirements of existing customers and an additional 50,000,000 cu ft of daily capacity for a transportation service for Consolidated Edison Company.

Tennessee Files $5,000,000 Budget-Type Application

A budget-type application by Tennessee Gas Transmission Company, has been accepted for filing, the Federal Power Commission announced.

Tennessee Gas proposes to construct facilities needed to take into its system natural gas purchased from independent producers during 1959. Total cost of such facilities, the company said, would not exceed $5,000,000, with the total cost of any one connection not to exceed $500,000.

Major Expansion By Great Lakes

Great Lakes Pipe Line Company recently announced a $10,000,000 construction program, the first project of which is a 12-in. line between Iowa City, Iowa, and Middlebury Junction, Illinois.

The first project will give the company a 12-in. line from Des Moines to Chicago by closing the present 128-mile gap between its 12-in. lines from Des Moines to Iowa City and from Middlebury to Chicago. The new 12-in. line will parallel the company's existing 6-in. line from Des Moines to Chicago and an 8-in. from Des Moines to Middlebury.

A new terminal will be located at Marshall, Minnesota, site of a Great Lakes pumping station. A terminal office and two-spot transport loading facility will be built to be served by the existing nine tanks with a gross capacity of 200,000 bbl.

Other projects in this program to expand system capacity and increase the number of delivery terminals will be announced by the company as studies now underway are completed.

Contractors Named For Midwestern Line

Contractors have been named by Midwestern Gas Transmission Company for construction of its 350-mile, 30-in. pipeline from Portland, Tennessee, to Joliet, Illinois.

Contracts were let to: Grayco Constructors, Inc., 51 miles from Portland to near Cromwell, Kentucky; Sharman, Allen, Gay and Taylor, Inc., 43 miles from near Cromwell to the Ohio River; Panama, Inc., 53 miles from the Ohio River to the White River near Algiers, Indiana; Majestic Contractors, Ltd., 53 miles from the White River to the Wabash River, near Terre Haute, Indiana; and Bechtel Corporation, 148 miles from the Wabash River to the terminus of the pipeline near Joliet.

The six major river crossings will be constructed as follows: Green River in Kentucky by Sharman, Allen, Gay & Taylor, Inc.; Ohio River on the Kentucky-Indiana state line by Pentzien, Inc.; White and Wabash rivers, both in Indiana, by Popich Marine Construction, Inc.; Kankakee River in Illinois by Missouri Valley Dredging Company; and the Des Plaines River in Illinois by Collins Construction Company.

In addition to the pipeline work, Houston Contracting Company has started construction of a Midwestern Gas compressor station with 6000 hp at Portland.

Completion of the line is expected in the fall.

First Deliveries By Gas Gathering System

South Texas Gas Gathering System's 120-mile phase I has opened with initial throughput of 50,000,000 cu ft daily to Texas Illinois Natural Gas Pipeline Company, inaugurating Coastal States Gas Producing Company's 32nd and largest gas gathering operation.

Canadian News Notes

Four Companies Seek Permit For British Columbia Line

The British Columbia Oil and Gas Conservation Board is considering four competing applications for permission to build a crude oil pipeline to serve the four principal oil fields in the province. All fields, Milligan Creek, Doig River, Beatton River and Boundary Lake, are in the northeastern sector, and oil is currently being trucked to the local refineries at Fort St. John (Taylor) and Dawson Creek.

First application to be heard was by Gibson Petroleum, Ltd., of Calgary, which proposes to build a completely new pipeline a distance of 395 miles to connect with the Trans Mountain main line at its Albreda pumping station about 150 miles north of Kamloops.

Second was the application of Peace River Oil Pipe Line (British Columbia) Ltd., an affiliate of Peace River Oil Pipe Line Company, Ltd. This company already has a crude oil line in operation between the Sturgeon Lake area oil fields and the Trans Mountain pumping station at Edson. The B. C. affiliate proposes to build a 233-mile line from the B. C. fields to the input station of the existing line at Valleyview, Alberta. It is proposed that B. C. crude would be put through the existing line into the Trans Mountain line, which would give it access to the same markets as those that would be reached by the Gibson line.

The remaining two proposals were filed by Trans-Prairie Pipe Lines, Ltd. and Pacific Petroleums, Ltd.

Trans-Prairie proposed a short line of 104 miles, with 40 miles of laterals, terminating at the Dawson Creek refinery of X-L Refineries, Ltd., with a short delivery lateral to the Taylor refinery of X-L on the way. Its plan was based, its brief contended, on the presumption that B. C. crude should be kept under B. C. control by using a pipeline entirely within the province. Such a line, it said, would assure also that the future needs of present and possible future refineries in the northeastern region would be capable of being supplied from sources within the same region.

The same argument was presented by Pacific, which proposed a similar line of about the same length, which would be routed directly past the Taylor refinery to a terminus at Dawson Creek.

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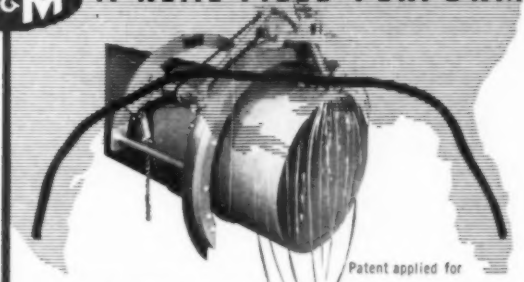

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WITH THE PIPELINE CONTRACTORS

CONSTRUCTION

FEATURE

● **Bechtel Corporation, 220 Bush Street, San Francisco 4, California.** Has been awarded a contract by *Midwestern Gas Transmission Company* to lay 148 miles of pipeline from the Wabash River to near Joliet, Illinois. One spread will operate out of Kankakee, Illinois, with M. A. Roberts as superintendent, the other from Georgetown, with M. A. Finnerty as superintendent.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has been awarded contracts by *Transcontinental Gas Pipe Line Corporation* to construct: 59 miles of 14 and 16-in. line from Mosquito Bay to Block 184, Eugene Isle, offshore Louisiana, with field office at Morgan City and W. E. Plake as superintendent; and 28 miles of 10-in. from Block 10, High Island, to Cameron Meadows, Louisiana, with field office at Cameron and R. R. Carlson as superintendent offshore, M. B. Kidd as superintendent of land lay, and Norman Beason as superintendent of the marsh spread. Also has received a contract to lay an undetermined amount of various size line in the Buras, Louisiana, area for *Shell Oil Company, The California Company*, and *Continental Oil Company*, with field office at Buras and John Landers as superintendent.

● **A. J. Curtis & Company, Box 111, Hickory, Pennsylvania.** Has a contract to lay 6 miles of 6-in. line from Bruin to Eau Claire, Pennsylvania, for *The Manufacturers Light & Heat Company*, and O. F. Bradford has been named superintendent and P. H. Carrell assistant superintendent. Also has contract from *New York State Natural Gas Corporation* to relocate 3000-ft of 20-in. line at the company's Preston Station near Waynesburg, Pennsylvania, with Melvin Landes as superintendent; and a contract from *Algonquin Gas Transmission Company* to relocate 6600-ft of 26-in. and bore 1675-ft for 30-in. casing in the vicinity of Danbury, Connecticut, with Melvin Landes as superintendent.

● **Engineers Ltd. Pipeline Company, 11858 San Pablo Avenue, El Cerrito, California.** Has been awarded a contract to construct 18 miles of 26-in. for *United Fuel Gas Company* from its Panther Mountain measuring station near Clendenin, West Virginia. Field office will be at Clendenin under the supervision of Bill Cook.

● **G.E.T. Construction, Inc., 435 S. 116th Street, Milwaukee, Wisconsin.** Has been awarded a contract by *Michigan Consolidated Gas Company* involving 14 valve relocations in Michigan. S. E. Trim is superintendent.

● **Grayco Constructors, Inc., P. O. Box 4147, Austin, Texas.** Has been awarded a contract by *Midwestern Gas Transmission Company* to lay approximately 51 miles of 30-in. from Portland, Tennessee, to a point on the Green River near Logansport, Kentucky. Field office will be at Bowling Green, Kentucky, with Emmett Wilkerson as spreadman.

● **Groninger & King, Inc., P. O Box 1381, Pampa, Texas.** Has been awarded a contract by *Skelly Oil Company* for an 8-mile, 4 and 6-in. gas injection system at Velma, Oklahoma. Field office is at Velma, and Frank Kelp is field superintendent.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Expect to start work September 1 on 120 miles of 8 in. through 14 in. for *South Texas Natural Gas Gathering Company* in south-central Texas.

● **Coates Field Service, Inc., P. O. Box 1581, Oklahoma City, Oklahoma.** Has contract for right-of-way acquisition for *South Georgia Natural Gas Company* on their 113-mile line in Georgia.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has been awarded contracts for the following work: 25 miles of 30-in. line from Ganaweh, Iran, to Khargu Island in the Persian Gulf, with H. C. Frankmann supervising; 25 miles of dual 32-in. lines from Fao, Iraq, to an artificial loading island, with Frankmann supervising; 52 miles of varying diameter from Mainland, Canada, to Vancouver Island; 5400-ft of 27½-in. from Tema, Ghana, into the ocean, with Lex King supervising; and a dual 6-in. pipeline link between Europe and Asia across Bosporous. Also has been awarded a contract to construct a crossing of the Des Plaines River in Illinois for *Midwestern Gas Transmission Company*.

● **Contracting & Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Has been awarded a contract by *Northern Illinois Gas Company* for the construction of a 22-in. natural gas pipeline between East Dubuque and Des Plaines, Illinois, with James H. McGill is project manager. Also, will lay 62.2 miles of 26 in. for *Trunkline Gas Company* from Tuscola to Rossville, Illinois.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta, Canada.** Has been awarded a contract by *Saskatchewan Power Corporation* to construct 80 miles of 10-in. from Success to Rosetown.

● **Engelking & James, Ltd., 408A 16th Avenue, N.E., Calgary, Alberta, Canada.** Has been awarded a contract to construct approximately 20 miles of 6-in. laterals in the Wayne, Chancellor, and Makepeace areas for *Alberta Gas Trunk Line Company, Ltd.*, and approximately 34 miles of 8-in. laterals in the Consort and Hilda areas.

● **Engineering-Construction Company, First National Bldg., Tulsa, Oklahoma.** Has received contract to lay 25 miles of various diameter lines for *North Carolina Natural Gas Corporation* from the company's main line to various tobacco farms. J. N. Underwood has been named superintendent, Paul Williams is foreman, and V. L. Bethel is office manager.

● **Fulghum Contracting Corporation, P. O. Box 1181, Harrisburg, Pennsylvania.** Has been awarded a contract to lay 100 miles of 12-in. pipeline from Watertown to Massena, New York, for *Niagara Mohawk Power Corporation*.

● **R. H. Fulton & Company, P. O. Box 1526, Lubbock, Texas.** Has been awarded a contract by *Michigan Wisconsin Pipe Line Company* to build 211.7 mile of 24-in. pipeline in Kansas, Nebraska, and Missouri. Also has contract from *Northern Natural Gas Company* to lay 11 1/10 miles of 30-in. pipeline north of Sunray, Texas, and 8 1/10 miles of 30-in. north of Beaver, Oklahoma, with A. A. Carrigan as job superintendent in the field office at Beaver.

● **H. L. Gentry Construction Company, 921 East Michigan, Jackson, Michigan.** Awarded contract by *Atlantic Seaboard Corporation* to lay 26-in. loops totaling 19.4 miles, and a 2230-ft crossing of the Shenandoah River.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has contract to lay approximately 117 miles of 30-in. natural gas pipeline for *Texas Gas Transmission Corporation* in central and north Louisiana, with R. L. Silar as superintendent. Also awarded contract to construct 41 miles of 30-in. natural gas pipeline for *United Gas Pipe Line Company* in the vicinity of Gulfport, Mississippi, and Mobile, Alabama. M. L. Thompson has been named superintendent. Also has been awarded a contract to lay 35 miles of 8 and 14-in. pipeline and a dual 12-in. Mississippi River crossing for *Monterey Pipe Line Company* in the vicinity of Thibodaux, Louisiana, where the field office will be located under R. E. Thornton, superintendent. Also has been awarded a contract by *Midwestern Gas Transmission Company* to construct a 6000-hp compressor station at Portland, Tennessee.

● **C. S. LeNoir Construction Company, P. O. Box 798, Austin 64, Texas.** Has been awarded a contract by *Trunkline Gas Company* to construct 57 miles of 30-in. line from near Union City to near Henning, Tennessee, and W. B. Williams has been named general superintendent of all construction. Also has received a contract to lay 19 miles of 24-in. starting at Enterprise, Mississippi, and 43 miles of 20-in. from Wetumpka to near Auburn, Alabama, for *Southern Natural Gas Company*. Also, has been awarded contract by Trunkline Gas Company to lay 57 miles of 30-in. from Polk to Brownsville, Tennessee.

● **Latex Construction Company, Box 12128, Atlanta 5, Georgia.** Has been awarded the following contracts: *Arkansas Fuel Oil Corporation*, the enlargement of a marine terminal at Port Everglades, Florida, R. D. Copeland in charge; *Everglades Pipe Line Company*, 35 miles of 10-in. from Ft. Lauderdale to Miami, Florida, with O. P. Hiner in charge, and construction of a pumping station in Port Everglades, with D. C. Rinehart in charge; and *Plantation Pipe Line Company*, reconditioning 90 miles of 4, 10 and 12-in. in Georgia, Mississippi, and South Carolina, G. H. Matlock in charge.

● **Macco Corporation, 14409 South Paramount Boulevard, Paramount, California.** Has prime contracts with various companies to construct pipelines in various sizes through 30-in. in California.

● **Majestic Contractors, Ltd., 408 Royal Trust Building, Edmonton, Alberta, Canada.** Has been awarded an undetermined amount of 4 through 10-in. crude oil gathering system to be constructed in the Estevan, Saskatchewan, area for *Producers Pipeline Company*. Jeff Minter is supervising at Estevan.

● **Majestic Contractors International, Ltd., 408 Royal Trust Building, Edmonton, Alberta, Canada.** Has been awarded a contract by *Midwestern Gas Transmission Company* to construct 52 miles of 30-in. line from Wheatland, Indiana, to the Wabash River. Field office will be at Sullivan, Indiana, with R. L. Leonard as superintendent.

● **Monarch Constructors, Inc., P. O. Box 3266, Odessa, Texas.** Has been awarded a contract by *Cameron Crude Oil Corporation (Wheat-Belt Pipe Line Company)* to lay 55 miles of 3, 4, 6, and 8-in. line from Sitka, Kansas, to Laverne, Oklahoma; and a contract by *Okan Pipeline Company* to lay 28 miles of 4-in. from Mocaine, Oklahoma, to the vicinity of Meade, Kansas.

● **Missouri Valley Dredging Company, P. O. Box 1592, Burlington Station, Omaha 8, Nebraska.** Has received a contract from *Midwestern Gas Transmission Company* to construct a crossing of the Kankakee River in Illinois.

● **Mannix Company Ltd., 737 8th Avenue, S.W., Calgary, Alberta, Canada.** Has been awarded a contract to construct 122 miles of 30-in. for *The Alberta Gas Trunk Line Company Ltd.* from Princess to Torrington, Alberta, with field office located in Brooks and V. J. Worcester as superintendent. Also has received a contract from *Pembina Pipe Line Ltd.* to lay 40 miles of 3 to 6-in. from the Pembina field. Field office for the latter is located in Drayton Valley, Alberta, and superintendent is S. Steffen.

● **Marine Pipeline & Dredging Ltd., 640 West Hastings Street, Vancouver 2, B. C., Canada.** Has been awarded a contract by *Saskatchewan Power Corporation* to construct 113 miles of 8-in. from Regina to Yorkton and 72 miles of 4 and 6-in. from St. Louis to Tisdale.

● **Oklahoma Contracting Company, P. O. Box 13227, Dallas 20, Texas.** Has been awarded a contract by *Southern Natural Gas Company* to construct 25 miles of 24-in. line from Gallion to Uniontown, Alabama, and 80 miles of 18-in. from Gwinville to Cranfield, Mississippi.

● **Panama, Inc., 2201 Commerce Building, Houston 2, Texas.** Has been awarded a contract by *Midwestern Gas Transmission Company* to construct 53 miles of line from the Ohio River to the White River near Algiers, Indiana. Also, has contracted to lay 118 miles of 30 in. from Kilbourne, Louisiana, to Ballentin, Mississippi, and 60 miles of 30 in. from Brownsville to Canadaville, Tennessee, and from Bardwell, Kentucky, to Polk, Tennessee, for *Trunkline Gas Company*.

● **Pentzien, Inc., 1504 Dodge Street, Omaha, Nebraska.** Has been awarded a contract by *Midwestern Gas Transmission Company* to construct a crossing of the Ohio River on the Kentucky-Indiana state line.

● **H. C. Price Company, Price Tower, Bartlesville, Oklahoma.** The pipe coating division has been awarded a contract by *El Paso Natural Gas Company* to apply internal coating to approximately 242 miles of 30-in. pipe in New Mexico. The job will be located near Gallup under the supervision of Joe Erdman. A contract for pipeline construction has been received from *Tennessee Gas Pipeline Company* for approximately 30 miles of 30-in. in Kentucky and approximately 29 miles of 26-in. in Kentucky and West Virginia. C. R. Ice is superintendent and headquarters will be in Morehead, Kentucky. Also has received a contract from *Texas Eastern Transmission Corporation* to construct a 30-in. road crossing near Mt. Sterling, Kentucky. W. H. "Blondie" Olrich will be superintendent at Danville, Kentucky.

● **Alex Robertson Company, 14433 Paramount Blvd., Paramount, California.** Has been awarded a contract to construct 60 miles of 20-in. from Cuyama to Ventura, California, for *Richfield Oil Corporation*, with field office in Ventura under the supervision of R. E. White and K. Pratt.

● **Western Pipe Line, Inc., P. O. Box 1076, Austin, Texas.** Has been awarded a contract by *Texas Gas Transmission Corporation* to lay 8.72 miles and 10.03 miles of 26-in. loops in Kentucky, where field office will be located at Cloverport, under John R. Wells, spreadman; and to lay 9.49 miles and 9.23 miles of 30-in. loops in Mississippi, where field office will be located at Shaw under Aldress Kilgore, spreadman. Also has been awarded a contract to lay 72 miles of pipeline for *Tennessee Gas Pipeline Company* from near Glasgow to Stanford, Kentucky. Will lay 43.3 miles of 4 to 20 in. from Lowry, Louisiana, toward shoreline, Vermilion Parish, Louisiana, for *Trunkline Gas Company*.

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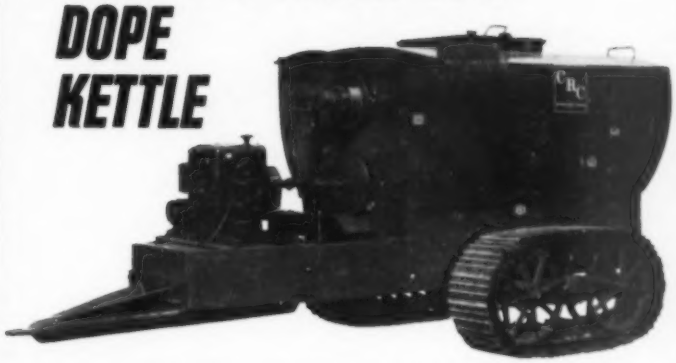

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Contractors

● **Rosson-Richards Processing Company, P. O. Box 908, Corpus Christi, Texas.** Has been awarded a contract by *Tennessee Gas Transmission Company* to clean and paint 200 miles of 30-in. in Wisconsin, with headquarters at Oak Creek under Elton Hood, superintendent. Also has been awarded a contract by *Trunkline Gas Company* to enamel and concrete-coat approximately 56 miles of 12, 14, and 16-in. pipe at the Delta Shipyard in New Orleans, Louisiana, with T. L. McPherson as superintendent; and a contract received from *Williams Brothers Company* to enamel and concrete-coat approximately 6660-ft of 24-in. at East Dubuque, Illinois, with McPherson as superintendent. Also has a contract with *Tennessee Gas Transmission Company* to clean, treat and Wate-Kote approximately 6000 ft of 24-in. pipe in Owensboro, Kentucky, and to clean, treat, and concrete coat approximately 6000 ft of 24-in. pipe at Wilmington, Illinois, with both jobs under the supervision of R. L. Miller.

● **Shamrock Construction Company, P. O. Box 1177, Lansing, Michigan.** Has received a contract from *Ohio Fuel Gas Company* to lay approximately 30 miles of 18 through 24-in. line in various locations in Ohio; and a contract from *Dow Chemical Company* in the vicinity of Midland, Michigan, for approximately 60 miles of 2, 4, 12, and 20-in. pipe. Also a second contract with *Ohio Fuel* for 12 miles of 16 and 20-in. circling Toledo, Ohio.

● **Sharman, Allen, Gay & Taylor, Inc., 3115 Buffalo Drive, Houston, Texas.** Has been awarded contract by *Freeport Sulphur Company* to lay approximately 33,000 ft of pipeline in south Louisiana. Field office for the latter job is Grand Isle, Louisiana, and spreadman is Chester Lake. Also has been awarded a contract by *Midwestern Gas Transmission Company* to lay 43 miles of line from near Cromwell, Kentucky, to the Ohio River and to construct a crossing of the Green River in Kentucky. Also has received a contract from *Southern Natural Gas Company* to lay approximately 64 miles of 6, 12, 16, and 20-in. in Lafourche and Terrebonne Parishes, Louisiana, with E. D. Singleton as spreadman at the field office at LaRose, Louisiana. Testing work began in July on 75 miles of 18-in. for *East Ohio Gas Company* in Columbiana, Mahoming, Belmont, Carroll, and Harrison counties. Headquarters are at New Philadelphia, Ohio. J. E. Allen is superintendent. Also, has been awarded contract to lay 41.9 miles of 24 in. from Moss Hill to Silsbee, Texas; 19.6 miles of 16 in. in the marsh and 5.3 miles of 14 in. in the Gulf to Block 26, Vermilion Parish, Louisiana, and 6.6 miles of 12 in. to Block 67, Camerion Parish, Louisiana, for *Trunkline Gas Company*.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has received a contract from *Consumers Power Company* to construct 40 miles of 24-in. pipeline from Woodbury to Laingsburg Junction, Michigan. Has been awarded a contract by *United Gas Pipe Line Company* to lay 49 miles of 30-in. from Lirette, Louisiana, to Lake Pontchartrain, with field office at Raceland, under O. R. Mitchell, superintendent; also a contract to lay 20 miles of 20-in. for *Louisville Gas and Electric Company* from Muldraugh to Louisville, Kentucky, where field office is located, with Earl Saulsman as spreadman; 15 miles of 20-in. in Iowa, 3 miles of 20-in. in Illinois, and 6660 ft of 24-in. across the Mississippi River for *Northern Natural Gas Company*, with field office at Dubuque, Iowa; and 45 miles of 20-in. from Mt. Seneca to Terra Alta, West Virginia, for *Atlantic Seaboard Corporation*, under Thelmer Davis, superintendent. Also has been awarded a contract by *Tennessee Gas Pipeline Company* to construct 70 miles of line from Portland, Tennessee, to near Glasgow, Kentucky. Also has been awarded a contract by *Kaneb Pipe Line Company* to lay 279 miles of 6-in. pipeline from Phillipsburg, Kansas, to Yankton, South Dakota, and G. R. Hamilton has been named superintendent; and a contract to construct 53 miles of 30-in. in Michigan for the *Michigan Consolidated Gas Company*. Also has been awarded a contract to construct 28 miles of 16-in. pipe on the western side of Lake Maracaibo for *Compania Shell de Venezuela*.

● **APV Company, Inc., 1801 Continental National Bank Building, Fort Worth, Texas.** Has been awarded contract to construct 61.4 miles of 30-in. from Pollock, Louisiana, to valve 63 for *Trunkline Gas Company*.

● **Sam Carline, Inc., Box 138, Berwick, Louisiana.** Has contracted to lay 24.5 miles of 12-in. for *Trunkline Gas Company* from Lowry, Louisiana, to Cameron Parish shoreline.

● **Engineers Limited Pipeline Company, 200 Bush Street, San Francisco, California.** Has been awarded contract to lay 136.6 miles of 26 in. from Rossville, Illinois, to visyula, Indiana, for *Trunkline Gas Company*.

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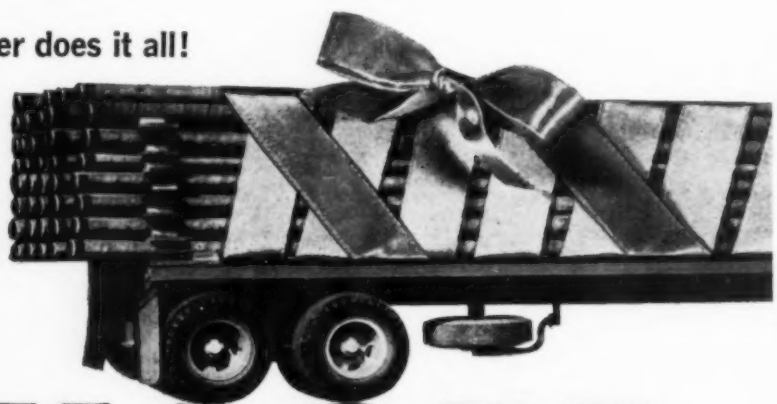

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PIPELINE PERSONALS

▸ **Lowell E. Anderson,** division chief engineer of the Wyoming division of Service Pipe Line Company, has been assigned temporarily to Pan-American International Oil Company for foreign service. **Robert H. Christman,** former section head in the Tulsa engineering department, has replaced Anderson.

▸ **Raymond L. Hirsch** has been appointed assistant to the vice president at Lima, Ohio for The Buckeye Pipe Line Company, and **Donald R. Merriman,** assistant to the vice president at New York.

Hirsch graduated from Ohio State University, and came to Buckeye in 1954 as an attorney after several years of private law practice in Columbus, Ohio.

Merriman is a graduate of Massachusetts Institute of Technology, and joined Buckeye in 1948. He is at present vice president of Everglades Pipe Line Company, Buckeye's Florida affiliate.

▸ **Gordon C. Bowen,** secretary-treasurer of Algonquin Gas Company, and **John B. Thorn,** director of sales and rates, have been named vice presidents.

Before joining Algonquin, Bowen held executive positions with Pan American World Airways, Inc., at Long Island City, New York, and with Pan American Grace Airways, Inc., at Lima, Peru. He joined Algonquin in 1952 as comptroller.

Thorn has been connected with the gas industry since 1935 when he was engaged by Ford, Bacon and Davis of New York as accountant and gas analyst. He became director of sales and rates for Algonquin in January, 1958.

▸ **H. D. McHenry,** vice president, secretary, and general counsel of Southern Natural Gas Company, has been elected executive vice president by the board of directors.

▸ **Paul R. Steele** has retired from New York State Natural Gas Corporation after 35 years' service with affiliated companies of Consolidated Natural Gas Company.

▸ **A. E. Hamalainen** has been named superintendent of Transcontinental Gas Pipe Line Corporation's compressor station No. 5 at Eunice, Louisiana, and **H. E. Melton** succeeds him as superintendent of compressor station No. 36 at Chatham, Virginia.

▸ **Clarke L. Coldren** has been named manager of Shell Pipe Line Corporation's technical development laboratory in Houston, according to an announcement from **H. M. Karr,** manager of technology. Coldren has been with Shell since 1952 and has been assigned to Shell Development Company's Emeryville, California, Research Center since that time.

▸ **Dr. Gus E. Montes** has joined Northern Natural Gas Company as technical director of the gas products development department. Dr. Montes will be responsible for all technical phases in the development of gas products for the company.

▸ **Guy Matheny** has been named superintendent of main lines for Peoples Natural Gas Company. Matheny has been with the company since 1924.

J. W. de Groot

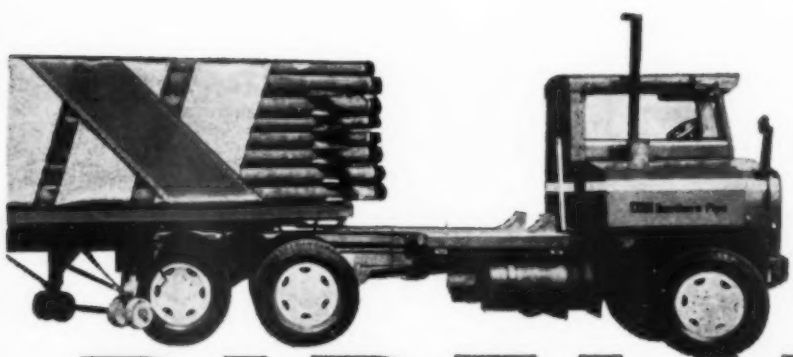
▸ **John W. de Groot,** who helped form the Annual Pipe Line Conference of the American Petroleum Institute and served as its chairman for nine consecutive years, has retired as president of Tuscarora Pipe Line Company, Ltd. He leaves active service after nearly 40 years in the Esso Standard Oil Company organization, the last 19 as an executive of Tuscarora, an Esso operating affiliate.

Donovan P. Dugan has been elected president of Tuscarora to succeed de Groot. He became superintendent of Tuscarora in 1947, and vice president and superintendent in 1950. In 1957 he accepted a loan assignment with the international staff of NATO in Paris, serving as head of the Petroleum Section. He returned to Tuscarora last January 1.

Don L. Cornell, chief engineer of Tuscarora since 1954, has been named superintendent and chief engineer.

▸ **F. C. Nicholson** has been elected a vice president of Northern Natural Gas Company, where he heads up the gas products development department. In addition, he is a vice president of Helex Company, a Northern subsidiary.

▸ **Commissioner Frederick Stueck** of St. Louis, Missouri, has taken the oath of office for his second five-year term as a member of the Federal Power Commission. Commissioner Stueck has been a member of the FPC since 1954.



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SOUTHERN PIPE PACKAGED PIPELINES GIVE YOU: (1) pipe produced to your exacting specifications, (2) from steel coil in our own pipe mill, (3) cut precisely with NO random lengths, (4) coated (or lined) at our plant, (5) warehoused, if necessary, until you need it, and (6) delivered to your trenchsite ready for welding and placing in trench. **PACKAGED PIPELINES** come in API monogrammed pipe or in Southern Pipe's own LITEWALL pipe—a new high strength, lightweight pipe manufactured to API specifications. (Southern Pipe warehouses standard sizes for immediate delivery, too.)

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Personals

▸ **James J. Trebilcott** and **Robert M. Hoffer** have been elected vice presidents of Michigan Wisconsin Pipe Line Company. Trebilcott also was elected to the board of directors and reappointed manager of operations, and American Louisiana Pipe Line Company elected Hoffer a vice president of that company.

▸ **Michael Curran,** formerly president of M. J. Crose Manufacturing Company and a senior vice president of Williams Brothers Company, has organized Curran & Company, Great Falls, Montana, to build oil, gas, and water pipelines.

▸ **Fred A. Crane,** superintendent right-of-way and claim department, Sinclair Pipe Line Company, has been elected national chairman of the American Right-of-Way Association. Crane, a veteran of 45 years service in pipeline right-of-way acquisition and claim work, has supervised acquisition of rights-of-way and lands for many thousands of miles of Sinclair Pipe Line Company and affiliated companies' pipelines, extending to major production, refining, and consuming areas within 14 states east of the Rocky Mountains, and to the District of Columbia.

▸ **Hy Yellin,** formerly chief engineer for Pipe Line Engineering Company, has opened a consulting engineering office in Dallas. Yellin, who joined Pipe Line Engineering Company in 1949, has worked on a number of important pipeline projects, including the Interprovincial Pipe Line, Buckeye's eastern products pipeline, Oleoducto del Pacifico, and a number of other major projects both in the United States and abroad.

A. L. Vaughan

W. B. Haas

▸ **W. A. Strauss,** executive vice president of Northern Natural Gas Company, has announced the election of three new vice presidents of the company. They are: **A. L. Vaughan,** vice president in charge of operations, Southern Region; **W. B. Haas,** vice president in charge of operations, Northern Region; and **J. O. Grantham,** vice president, employee relations. Vaughan and Haas, responsible for the administration of operating functions in their respective regions, were general managers of these regions prior to their election as vice presidents. Grantham, manager of employee relations before his promotion, has charge of the administration of the company's personnel policies, employee welfare programs, and employee development activities.

J. O. Grantham

▸ **J. G. Dickinson** has been elected a senior vice president of Natural Gas Pipeline Company of America, and newly-elected vice presidents include: **Keith Bentz, C. B. Randall,** and **F. P. Burns. J. M. Durrett** was named assistant secretary. Dickinson has been supervising production activities from the Amarillo, Texas, office since 1930 and has been a vice president of NGPL since 1949. Bentz has been assistant vice president of operations, Chicago; Burns has been assistant vice president of production, Amarillo; Randall has been director of tax and insurance, Chicago; and Durrett has been Amarillo office manager.

▸ **J. A. Lockard** has been appointed superintendent of warehousing for New York State Natural Gas Corporation. He joined the company in 1953 in charge of material control, and has been in the production department since 1958.

▸ **D. B. Furlong** has been elected president and general manager of Producers Pipelines, Ltd., and vice president and general manager of its affiliate, Westspur Pipe Line Company.

▸ **Fred B. Crandall** has been appointed general sales manager for T. D. Williamson, Inc., Tulsa. Crandall joined the firm in 1952 as research and development engineer. In 1956 he was appointed factory sales engineer for the upper Great Lakes area, residing in Jackson, Michigan, until January this year when he was appointed acting general sales manager. Before joining T. D. Williamson, Inc., Crandall was pipeline engineer with Phillips Petroleum Company in their Products Pipeline Department.

F. B. Crandall

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BLASTHOLER
Saves Time
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Speeds Blasting
This self-propelled rotary drill unit does the work of 4 men, 2 sidebooms and 2 compressors on most pipeline blasthole operations. Mounted on tracks for terrain mobility, the BLASTHOLER drills blast holes 2 to 5 times faster than other cumbersome equipment, carries own air for cleaning hole. Standard unit drills holes from 2¼" to 3⅞" in diameter to 9' depth. Mast travels 40" laterally for staggering holes across ditch width, can be adjusted 14 degrees for angle drilling. Cut costs — speed blasting! See the BLASTHOLER today!

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It's New Pipeline Equipment

FM Signal Generator For Servicing

A new FM signal generator designed for servicing FM mobile, portable, fixed station, and 2-way radio has been introduced. It covers 6 RF frequency bands between 25 and 960 mc. Ranges are 25-32, 32-41, 41-54, 140-175, 400-470, and 890-960 mc — each individually calibrated to an accuracy of ± 0.5 percent. Output voltage is continuously variable from 100,000 microvolts to 0.1 microvolts and is calibrated from – 8 to – 128 dbm. An internal 1000-cycle oscillator provides a modulating signal which produces 0-15 kc deviation. Deviation for the 4 lower frequency bands is indicated directly on the panel meter and is accurate to ± 10 percent. Correction curves are used for the higher frequency ranges. Instrument also covers 4 intermediate frequency bands of 2.0-4.2, 4.1-6.0, 6.8-9.4 and 69.0-76.0 mc. Designated Model T1034-A, it operates from a 117 vac power source and draws 70 w, and may be used to check receiver sensitivity, discriminator slope, receiver sensitivity with tone modulation, audio recovery, IF strip for defective stages and audio output; to supply intermediate frequencies for alignment; and to provide accurately metered increments of carrier frequency and other frequency modulated signals using an external source. *Motorola Inc.*

Circle number (81) on reply card.

Multiplex Carrier

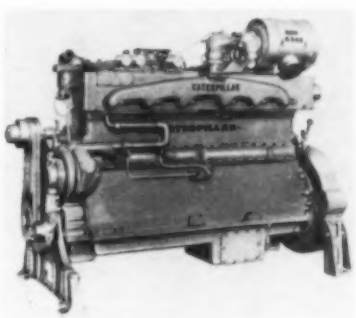
A new 24-channel FM carrier system featuring full compatibility with telephone transmission standards has been announced by Raytheon for channelizing its MCR-1000 microwave radio communications line. B-640 multiplex carrier, designed and manufactured for Raytheon by Lynch Carrier Systems, features transmitter crystal-control and miniaturized plug-in assembly. B-640 provides voice channels over FM subcarriers in the 40 to 420 kc base band. The carrier equipment may be separated from the associated RF equipment by several miles of wireline or cable. System design includes optional transistorized repeaters. Available signalling includes E and M dial, ringdown, common battery loop, VHF control, and other special microwave services. Each basic channel-terminal unit is so designed that it will operate with any of these signalling methods by proper strapping. The equipment is powered from either 48-v batteries or 115-v a-c mains. The a-c power supply uses silicon diode rectifiers, long-life magnetic components, and telephone-type capacitors. *Raytheon Company.*

Circle number (82) on reply card.

New Valve Isolates Line Breaks Quickly

For use on transmission lines at section valves and at regulator compressor stations, to isolate line breaks quickly, is a new differential operated trip valve — a manual reset snap-action valve operator which is tripped by a differential of pressure across an orifice or valve. Maximum inlet pressure is 1000 psi. Reliance Type 196 is available in 2 models: Type 196-6 has a differential range of 50-300 in. wc and operates on an increase in differential pressure, such as would result from a downstream break; Type 196-2 has a differential range of 4-75 in. wc and operates on a decrease in differential pressure, such as would result from an upstream break. *Reliance Regulator Division, American Meter Company.*

Circle number (83) on reply card.



New Gas Engine

A new, spark-ignited engine, designed to operate on a wide variety of gaseous fuels, has been announced. Two compression ratios are available — 10:1 for high efficiency operation with methane type gases and 7.5:1 for use with liquefied petroleum, field gases, or any other gaseous fuels. The former is rated at 225 hp and the latter at 200 hp. Both ratings are for continuous duty at 1200 rpm. By changing the pistons and fuel system, the new Cat G342 engine can be converted to diesel operation. Other features include a new dry-type air cleaner and a low tension ignition system. *Engine Division, Caterpillar Tractor Company.*

Circle number (84) on reply card.

Plastic Pipe Lining To Combat Corrosion

A new plastic pipe lining of 100 percent solids with no solvents has been developed to combat corrosion inside pipe. The new lining combines 4 different resins. Coating is applied by depositing the plastic in the pipe and then spinning the pipe at high speed revolutions to get a dense and uniform thickness of the lining inside the pipe and to eliminate all pinholes in the finished coating. *Tube Process Corporation.*

Circle number (85) on reply card.

Copper Strip For Cathodic Protection

Replacing copper cable around pipeline joint connections with soft copper strip has been developed by Bridgeport Brass Company as a new way to continue the flow of static electricity in a number of applications along oil and gas pipelines. Strip offers greater footage per pound, no loss of electrical conductivity, it need not be insulated against corrosion, and is easier to weld to the pipe. *Bridgeport Brass Company.*

Circle number (86) on reply card.

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Pipeline
Cleaner

for BETTER cleaning of
CRUDE LINES
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REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Complete encirclement saddles.

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New Pipeline Literature

New Microwave Concept

A bulletin describes new "Dual-Beam" microwave equipment. The bulletin explains how cross-polarization of antennas makes continuous parallel operation of 2 sets of RF equipment possible, thus increasing reliability of the total system. *General Electric.*

Circle number (87) on reply card.

World-Wide Service, Equipment Guide

A 1959 "World-Wide Guide" to Dresser equipment and technical services has been announced. In 68 color pages it lists Dresser representatives and their addresses in various countries, products and services in 77 categories, and a pictorial section gives a display of equipment on the job throughout the world. *Dresser Industries, Inc.*

Circle number (88) on reply card.

Communications Data

Broadcast equipment, HF-VHF ground systems, microwave systems, and Kineplex data systems are included in 79 illustrated pages that compose Collins Radio Company's general catalog for 1959. *Collins Radio Company.*

Circle number (89) on reply card.

Trencher Bulletin

A new 4-page folder describes, aided by simplified mechanical illustrations, new design and construction features in terms of how they improve the operation of 3 Cleveland "J" trenchers. Digging capacities, specifications, and dimensions are compared, and "on-job" photos are shown. *The Cleveland Trencher Company.*

Circle number (90) on reply card.

Heavy-Duty Packaged Field Compressor

A new illustrated bulletin describes a 2 cylinder, heavy-duty packaged field compressor designed for single or 2-stage applications where greater horsepower is required in a 2-cylinder machine. Horsepower sizes range from 200 to 350 bhp with engines operating at 1000 rpm. Case and running gear are described as extra-heavy throughout to accommodate the increased horsepower ratings. *Clark Bros. Company.*

Circle number (91) on reply card.

Bulletins Picture Scraper, Tractor

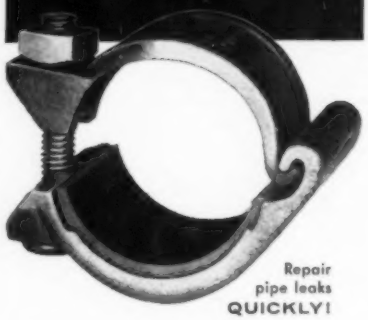
Pictures of Allis-Chalmers' TS-260 motor scraper, its power plant, power train, and many of the important components, as well as the manufacturer's 20-ton TR-260 rear dump wagon, and specifications of both, are included in newly-issued bulletin MS-1312. A second bulletin, MS-1251, covers the company's HD-6 diesel-powered crawler tractor in pictures, graphs, and charts. *Allis-Chalmers Manufacturing Company.*

Circle number (92) on reply card.

NOW A

JUNIOR

EMERGENCY PIPE CLAMP



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A companion to the old reliable Emergency Pipe Clamp that has served industry for a half-century. Just 2⅞" wide. Made of malleable iron, it has a full-width hinge along one side, and a single oversized, plated bolt on the other. Lug on gasket half is slotted for "sliding" bolt into place—without removing nut. Gasket is cemented in. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write today for circular on the JUNIOR.

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EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

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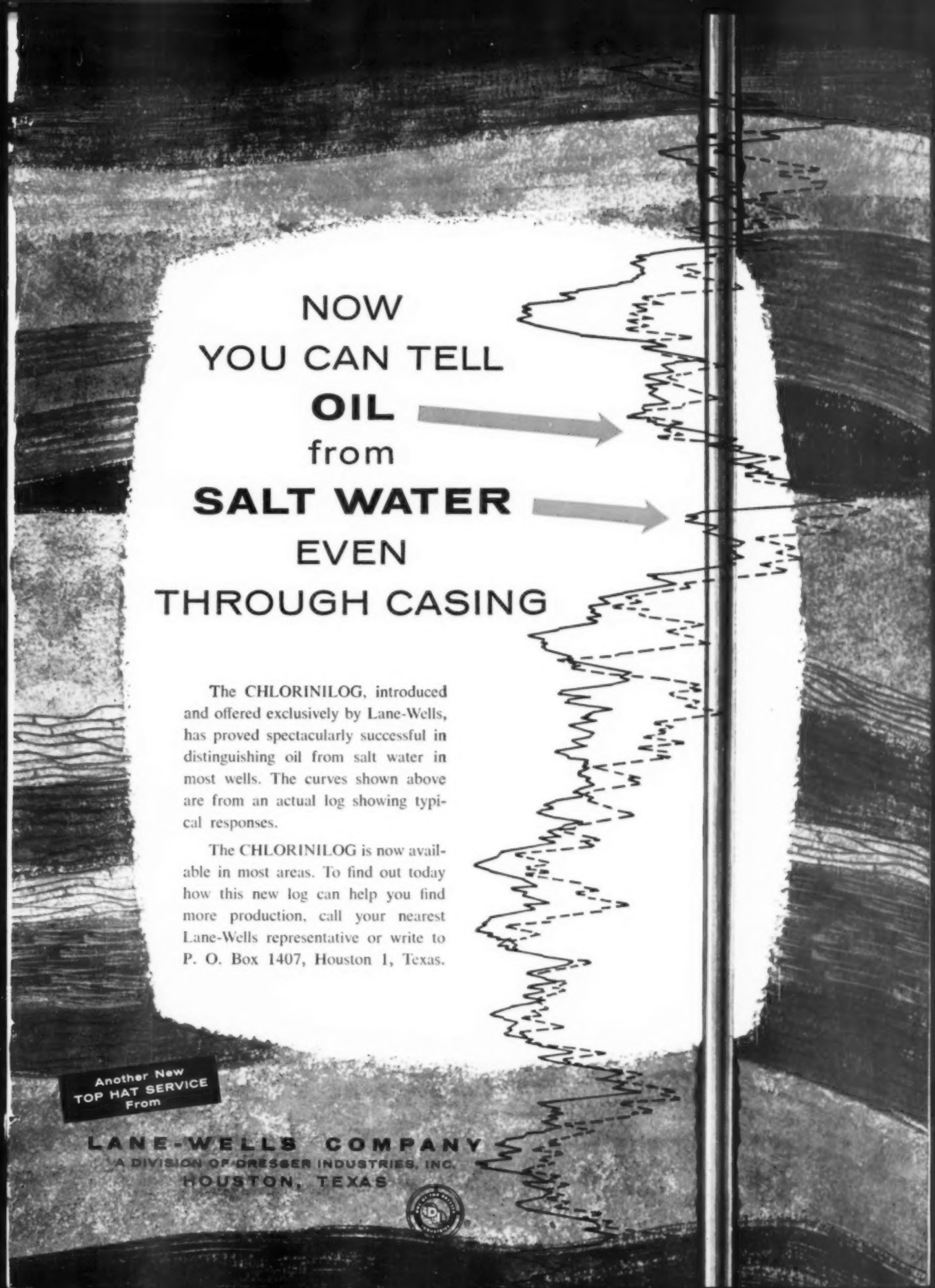
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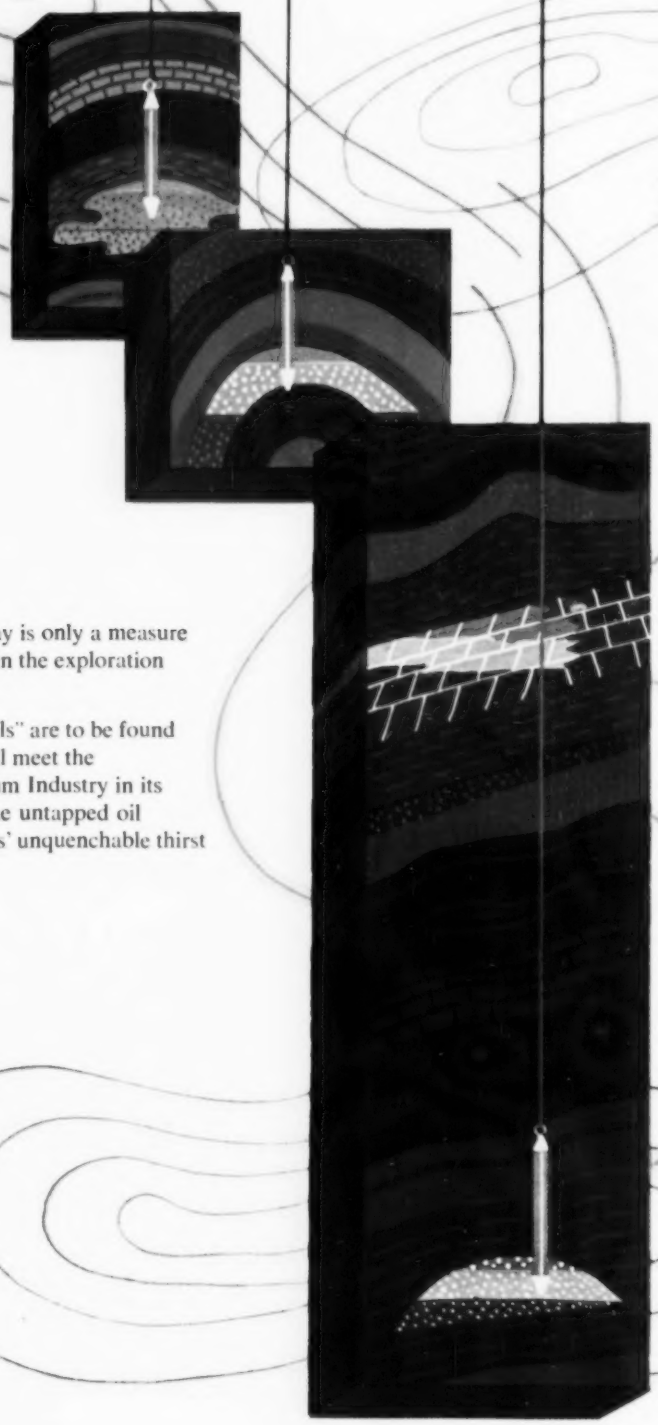

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